Göttinger Wirtschaftsinformatik

Herausgeber: J. Biethahn† • L. M. Kolbe • M. Schumann

Markus Mandrella

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## Theory Integration, Extension, and Adaptation to the Wood Industry

Band 94

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# IT-Based Value Co-Creation in Inter-Organizational Networks

## Theory Integration, Extension, and Adaptation to the Wood Industry

**Dissertation**

zur Erlangung des wirtschaftswissenschaftlichen Doktorgrades
der Wirtschaftswissenschaftlichen Fakultät der Georg-August-Universität Göttingen

vorgelegt von
Markus Mandrella, M. Sc.
aus Hindenburg

Göttingen, 2017

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# Preface

This cumulative dissertation was written during my engagement at the DFG Resource Training Group 1703 “Resource Efficiency in Interorganizational Networks” and the Chair of Information Management at the University of Göttingen. It encompasses six studies on IT-based value co-creation in inter-organizational networks. This work would not have been possible without the help and support of many others.

First of all, I would like to thank my family for their great support. I would like to start with my fiancée, Runhild, for her incredible help and support during the last months. Getting to know you was the most important thing during my PhD! Furthermore, I would like thank my parents, Danuta and Georg, for their continuous support throughout my life and for granting me the opportunity to study and live in Göttingen. Without your support this dissertation would not have been possible. I would also like to thank my grandparents, Irmgard and Alfons, for always being there. Finally, thanks go to my new family members, Regina, Walter, Mechthild, and Karsten, for a great time together and their support.

My sincere thanks go to my first supervisor, Prof. Dr. Lutz M. Kolbe, for granting me the opportunity to start my dissertation project and his friendly and helpful cooperation. I particularly would like to thank him for the great mix of structure and opportunities on the one hand, and the freedom to develop my own ideas and to do research I am interested in on the other hand. Furthermore, my thanks go to Prof. Dr. Waldemar Toporowski for being part of my thesis committee, for his helpful suggestions, and for evaluating my work. Moreover, I would like to thank Prof. Dr. Carsten Mai for supervising me and bringing a different yet fruitful perspective from the context of the wood industry. My thanks also go to all other professors at the RTG for providing important feedback in the doctoral colloquiums and beyond.

Furthermore, I would like to thank my friends from Göttingen and Goslar for all the fun, the support, and the great weekends, festivals, travels, and much more during my PhD. Special thanks go to Tim and Hendrik for being great flatmates.

Last but for sure not least, I want to thank all my current and former colleagues from the Chair of Information Management, SMRG, and DTRC for the assistance and cooperation in the last three years. Special thanks go to my former colleagues, Nicky, Thierry, Simon, and Sebastian, for the fantastic working atmosphere and the great time at the “Blauer Turm”.

Göttingen, December 2017 *Markus Mandrella*

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# Acronyms

| | |
|---|---|
| AIS | Association for Information Systems |
| AMCIS | Americas Conference on Information Systems |
| AVE | Average Variance Extracted |
| CAD | Computer-Aided Design |
| CFA | Confirmatory Factor Analysis |
| CMV | Common Method Variance |
| CNC | Computerized Numerical Control |
| CoSeMat | Common-Sense-Material Master |
| CR | Composite Construct Reliability |
| CSV | Comma-Separated Values |
| DFG | Deutsche Forschungsgemeinschaft (*German*) |
| ECIS | European Conference on Information Systems |
| EDI | Electronic Data Interchange |
| ELDAT | Elektronischer Datenaustausch Holzdaten (*German*) |
| ERP | Enterprise Resource Planning |
| EU | Environmental Uncertainty |
| FHP | Forst, Holz, Papier (*German*) |
| FL | Factor Loading |
| GCPC | Global Cleaner Production & Sustainable Consumption Conference |
| HICSS | Hawaii International Conference on System Sciences |
| ICIS | International Conference on Information Systems |
| IFIS | Integrated Forestry Information Systems |
| IOR | Inter-Organizational Relationship |
| IOS | Inter-Organizational System(s) |
| IS | Information System(s) |

| | |
|---|---|
| IT | Information Technology |
| JAIS | Journal of the Association of Information Systems |
| JIT | Journal of Information Technology |
| MISQ | Management Information Systems Quarterly |
| OIPT | Organizational Information Processing Theory |
| OM | Operations Management |
| OMS | Operational Management System(s) |
| PACIS | Pacific Asia Conference on Information Systems |
| PLS | Partial Least Squares |
| RBV | Resource-Based View |
| ROA | Return on Assets |
| ROS | Return on Sales |
| RTG | Research Training Group |
| SaaS | Software-as-a-Service |
| SAM | Strategic Alignment Model |
| SCM | Supply Chain Management |
| SCP | Supply Chain Performance |
| SEM | Structural Equation Modelling |
| SME | Small and Medium-Sized Enterprises |
| UPS | United Parcel Service |
| URI | Uniform Resource Identifier |
| VHB | Verband der Hochschullehrer für Betriebswirtschaft e.V. (*German*) |
| VAF | Variance Accounted For |
| VIF | Variance Inflation Factor |
| XML | Extensible Markup Language |

# A. Foundations

The first chapter of this cumulative dissertation is divided into two sections. In the first section (A.I), an introduction to investigating information technology (IT) business value generation in inter-organizational networks is provided. It includes the motivation, research questions and structure, research context and design, and the anticipated contributions of this thesis. In the second section (A.II), the theoretical background is presented. It includes theoretical foundations of both inter-organizational networks as well as IT-based value co-creation, and provides an overview of the wood industry.

# I. Introduction

The first section derives the relevance of the research topic, followed by outlining the research gaps and questions. Subsequently, the underlying structure of this thesis as well as its overall research context and design are described. Lastly, the anticipated contributions of this dissertation for research and practice are outlined.

## I.1 Motivation

Besides the longstanding tradition of inter-organizational cooperation, competition growth in innovation, time, quality, and costs forces firms to collaborate in inter-organizational networks (Siebert 2003), having led to an increased number and importance of inter-organizational arrangements in the last three decades (Gulati 2007; Ozmel et al. 2013). By both working together and combining resources, firms are able to reduce costs, increase flexibility, obtain competencies and new knowledge, access new resources and markets, and share risks (Sydow 2003). IT plays a critical role in the functioning of inter-organizational networks. In addition to the support of collaboration by improving coordination and communication (Chi and Holsapple 2005), IT also enables completely new types of inter-organizational collaboration, such as platform ecosystems (Ceccagnoli et al. 2012) and virtual organizations (Paul and McDaniel 2004). For example, highly automated logistic networks like United Parcel Service (UPS) (Rai et al. 2006), payment networks such as Visa, Inc. (Markus and Bui 2012), and digital platforms like the "Apple Store" (Grover and Kohli 2012) are not conceivable without the utilization of information and communication technologies. As a result, inter-organizational systems (IOS) can be seen as a key resource in inter-organizational networks.

Investments in IT account for approximately 30 percent of all business investments in companies (Saunders and Brynjolfsson 2016), and a positive trend persists (Kappelman et al. 2016). Financial volumes of IOS, such as supply chain management software, are also on the rise (Forbes 2013). Although firms widely recognize the business value of IT spending, capital investments in IT are clearly seen as riskier than non-IT investments such as R&D investments (Masli et al. 2014). Studies report that up to 50 percent of all IT investments fail to deliver returns (Cognizant 2013), with 45 percent of IT projects running over budget, and 56 percent delivering less value than expected (Bloch et al. 2012). In the context of inter-organizational networks, where collaboration per se is reported to have high failure rates of about 50 percent (BPI Network 2014), these issues are even more critical. Firms aiming to realize returns from joint IT investments through value co-creation face even more challenges, including shared investments, risk allocation, development of joint capabilities, and providing incentives to cooperating organizations (Grover and Kohli 2012).

The described issues are particularly relevant for the wood industry. During the last years, the importance of processing wood has increasingly been recognized by economic and public sectors (Höglmeier et al. 2017). First, wood serves as a carbon pool and important substitute for fossil-based materials (Werner et al. 2005). For instance, the wood industry contributes to a total saving of 105.5 million tons of CO2 emissions per year due to the usage of wood materials and sink effects of products and forests (Rüter et al. 2011). Accordingly, the utilization of wood is seen as an integral part of the transition to a bio-based economy (Höglmeier et al. 2017; Scarlat et al. 2015), and is also subject to environmental public initiatives, such as the European Resource Efficiency Initiative (Huysman et al. 2015). Second, wood resources can be utilized for a high variety of purposes, such as construction, paper production, or energy consumption, while additionally being used multiple times through recycling and recovery (Mantau 2011), hence increasing their rising economic potential (Ollikainen 2014). The economic importance of the wood sector is further reflected by its accounting for more than one million employees and an annual turnover of about €175 billion (Becher 2016), being one of the largest industries in Germany (Mrosek et al. 2005).

However, due to the limited availability of wood as natural resource, and its increasing use for energy purposes, intensified competition (including rising prices) is observed (Schwarzbauer and Stern 2010). Therefore, cooperating in inter-organizational networks is important for wood processing companies in order to optimize the efficient use of wood materials through cascade utilization (Narodoslawsky 2003; Shahriari et al. 2015). In this context, IOS play an important role. By facilitating the transfer and exploitation of information between companies, these systems contribute to the reduction of uncertainties and the improvement of the utilization of resources (Fröhling et al. 2011; Uusijärvi et al. 2010), thus leading to diverse benefits for companies in this sector (e.g., Appelhanz et al. 2016; Osburg et al. 2016; Taskhiri et al. 2013; Zander 2017). However, the surprisingly low diffusion of IOS in the wood industry (e.g., Arano and Spong 2012; Hewitt et al. 2011; Trang 2015) indicates that organizations in this sector currently do not fully realize the potential benefits, underpinning the need to examine how IT investments pay off in this context. Consequently, the wood industry represents a suitable and relevant case for research on IT-based value co-creation.

The overall aim of this thesis is to contribute to the understanding of how IT creates business value in inter-organizational networks and, therefore, to extend IT business value research (Kohli and Grover 2008; Masli et al. 2011; Melville et al. 2004; Schryen 2010). In particular, this dissertation has three main objectives. First, it aims to resolve contradictory findings in this research field by drawing on reference theories and considering contextual factors to integrate results of previous studies. Second, another goal lies in the explanation of IT-based value co-creation mechanisms, including their key capabilities and interdependencies, by extending the identified reference theories. Third, this thesis aims to offer insights on IT-based value co-creation in the wood industry by adapting the derived theoretical findings to this specific context. The third objective is motivated by the fact that social science research in general (Pawson and Tilley 1997), and more recently IT business value research in particular (Wong et al. 2012), highlight the idea that causal relationships depend on the contextual conditions, e.g., the investigated industry. Moreover, such applied theory research (Robey and Markus 1998; Rosemann and Vessey 2008) increases the practical relevance by adapting an appropriate theory to address a specific problem relevant to practice. As stated above, utilizing renewable resources in inter-organizational networks in the wood industry represents a relevant issue for economy and society. The need for analyzing how inter-organizational IT leads to value in a specific supply chain context is highlighted by Venkatesh (2013, p. 281) who states: "If I had to use one word to describe what symbolizes future of research in this area, it is context."

## I.2 Research Questions

To advance the understanding of how IT business value can be created in inter-organizational networks, this thesis follows a reference theorizing approach (see Section A.I.5). Accordingly, this thesis is structured along three steps, i.e., theory integration, theory extension, and theory adaptation, each addressing a particular research question (RQ). The pursued research approach and the corresponding research questions are shown in Figure A-1.

The first part of this thesis aims to integrate previous research insights to advance the understanding of how inter-organizational networks create value from IT investments. Scholars found that inter-organizational networks mainly strive to achieve two types of business value by utilizing IT resources. First, studies reveal that network partners attempt to realize relational rents from inter-organizational relationships, which ultimately result in organizational performance (Dyer and Singh 1998; Lavie 2006; Prasad et al. 2013). Second, as these studies are criticized for being static and unsuitable for dynamically changing environments (Wade and

Hulland 2004), scholars increasingly highlight the critical role of organizational agility in inter-organizational settings (e.g., Gosain et al. 2004; Liu et al. 2013; Sambamurthy et al. 2003).

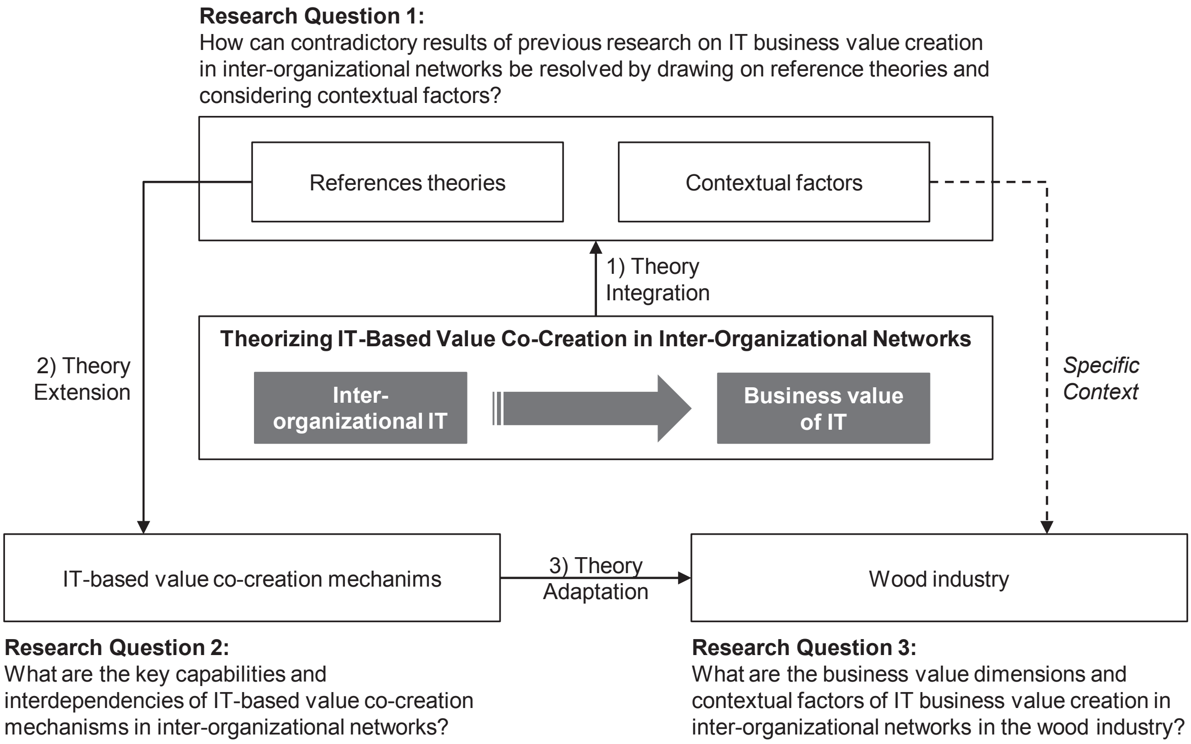


*Figure A-1. Research approach and corresponding research questions*

Yet, research on IT business value in general and on IT-based value co-creation in particular is characterized by contradictory findings (Brynjolfsson 1993; Sabherwal and Jeyaraj 2015). In contrast to studies that find a positive relationship between IT and business value in this context, some scholars also demonstrate insignificant or even negative impacts of IT on both relational value (e.g., Hyvönen 2007; Saldanha et al. 2013; Truman 2000) and organizational agility (e.g., Gosain et al. 2004; van Oosterhout et al. 2006; Overby et al. 2006). On the one hand, the contradictory findings stem from a missing common theoretical understanding and a highly scattered application of reference theories (Madlberger 2011). On the other hand, contextual factors, such as the type of interfirm relationship and the applied research methodologies, likely affect the impact of IT on business value in inter-organizational settings (Grover and Saeed 2007; Wong et al. 2012). These contradictory findings in the extant literature limit the understanding of how inter-organizational networks create value from IT. Therefore, a first research question is proposed:

> ***RQ 1:*** *How can contradictory results of previous research on IT business value creation in inter-organizational networks be resolved by drawing on reference theories and considering contextual factors?*

In the second part, the goal lies in the extension of the reference theories to gain insights into IT-based value co-creation mechanisms in inter-organizational networks. Researchers typically theorize mechanisms of value co-creation as a capability-building process, resulting in a hierarchy of capabilities in which lower-order capabilities shape the development of higher-order capabilities (Lee et al. 2015; Rai et al. 2006). Following this argument, scholars have empirically demonstrated the positive impact of various inter-organizational IT capabilities, such as IT infrastructure integration, information integration, IT-enabled planning and control, and IT partner support on intermediate factors, e.g., supply chain integration (Rai et al. 2006), process coupling (Saraf et al. 2007), and relational responses (Wang et al. 2013). Moreover, direct impacts on relational value have been found (e.g., Dong et al. 2009; Wong et al. 2012; Zhu and Kraemer 2005).

However, the understanding of how inter-organizational IT capabilities relate to each other, and consequently how the IT-based value co-creation mechanisms can be decomposed, remains underresearched. Although a number of IT capabilities has been found to shape co-created value, their interdependencies in the capability-building process are rarely examined. Moreover, important intra-organizational business value concepts, such as IT alignment (Coltman et al. 2015), are barely considered in inter-organizational settings. This is also highlighted in the MISQ special issue on co-creating IT value, where Grover and Kohli (2012, p. 231) ask researchers to "focus more on interdependencies between the layers" and to "expand the sources of IT-based cocreated value." In information systems (IS) research, this research gap is frequently accompanied by an exogenous treating of the IT artifact and a lack of embedding it into context (Grover and Lyytinen 2015). Therefore, IT-specific phenomena of value co-creation mechanisms remain largely unexplored. These issues limit the understanding of how IT leads to value in inter-organizational networks, leading to the following research question:

> ***RQ 2:*** *What are the key capabilities and interdependencies of IT-based value co-creation mechanisms in inter-organizational networks?*

Finally, the third part aims to instantiate and modify the findings on IT-based value co-creation mechanisms to the specific context of the wood industry. Research on IT business value increasingly highlights the role of both contextual factors (Melville et al. 2004; Wong et al. 2012) and differentiating business value dimensions (Grover and Kohli 2012; Kohli and Grover 2008). In the context of the wood industry, it has been pointed out that the industry is characterized by a low-to-medium degree of IS adoption (Arano and Spong 2012; Hewitt et al. 2011; Trang 2015). However, studies have shown that IOS can be beneficial for organizations collaborating in the wood industry, for example by reducing costs (Appelhanz et al. 2016), increasing the acceptance of sustainable products (Osburg et al. 2016), and reducing negative environmental impacts (Taskhiri et al. 2013). Moreover, it has been empirically demonstrated that inter-organizational IT capabilities can lead to value for these companies (Zander 2017).

However, the understanding of the IT value creation mechanisms in the wood sector needs to be further extended due to the following special characteristics of the industry: First, the processing of wood is associated with high levels of uncertainties regarding the resource quantity, quality, and availability, resulting in the need to optimize resource efficiency (Daian and Ozarska 2009; Geldermann et al. 2016). Second, organizations in the wood industry represent a special type of inter-organizational networks as they cooperate in supply-chained regional clusters (Kies et al. 2010) and are influenced by a number of industry characteristics (Zander et al. 2015b). Previous research on IT value co-creation has mainly focused on direct economic benefits of IT (Masli et al. 2011), such as supply chain performance (e.g., Chen et al. 2013; Saeed et al. 2011; Wong et al. 2012). However, multiple objectives and criteria regarding the efficiency of renewable resources have to be considered to capture the business value of IS adequately (Zander 2017). Moreover, contextual factors of processing natural resources influence the structures, processes, and technologies in these networks (Narodoslawsky 2003), and hence need to be modeled in this value co-creation process. Therefore, this thesis finally aims to answer the following research question:

> ***RQ 3:*** *What are the business value dimensions and contextual factors of IT business value creation in inter-organizational networks in the wood industry?*

## I.3 Structure of the Thesis

As illustrated in Figure A-2 and Table A-1, this thesis is cumulative in nature and consists of three parts, including six interrelated studies. While the first and last part (Part A and Part C) frame and integrate the research findings, the middle part (Part B) comprises the conducted studies in three subsections, each focusing on one of the three research questions presented in Section A.I.2. Three studies have been published in peer reviewed international IS conference proceedings, and three studies are currently under review in renowned IS journals.

**Part A** ("Foundations") starts with the motivation of the thesis, followed by the central research questions. Next, the research context and the research design as well as the anticipated contributions are presented. Following this, the subsequent section comprises the theoretical background. Initially, the foundations of inter-organizational networks as a distinct organizational form are provided, followed by the introduction of fundamental concepts of IT-based value-co-creation. The last subsection gives an overview of the wood industry as a specific context.

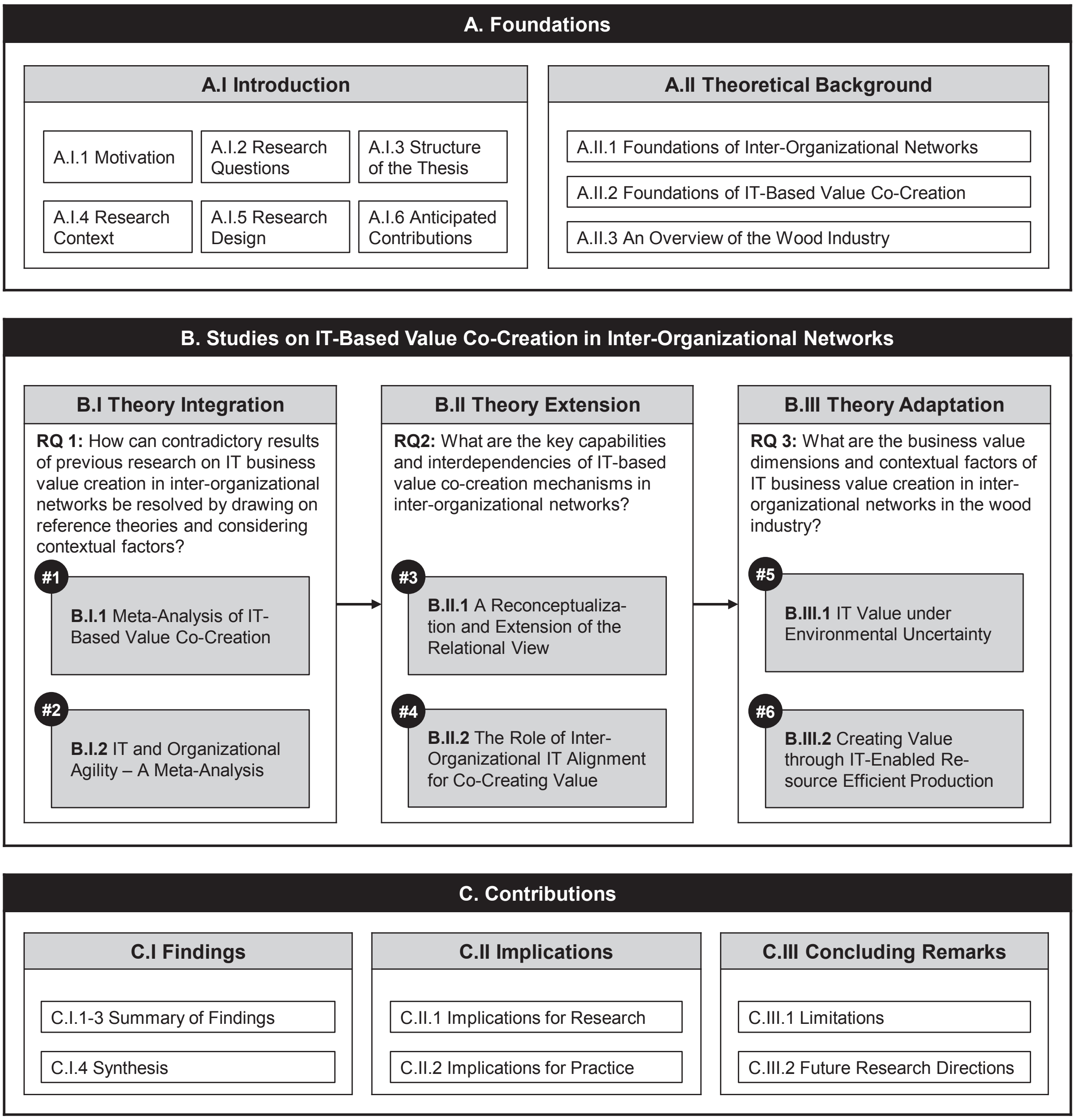


*Figure A-2. Overview of the structure of the thesis*

**Part B** ("Studies on IT-Based Value Co-Creation in Inter-Organizational Networks") corresponds to the main body of this cumulative thesis, and includes six studies in three subparts. **Part B.I** aims to address the first research question. The objective is to integrate previous research findings by drawing on reference theories and considering contextual factors to resolve contradictory findings on relationships between IT and business value that are essential for inter-organizational networks. Both studies conduct a meta-analysis. The first study (#1) investigates the relationship between inter-organizational IT factors and business value while also exploring the role of moderating factors. While the first study does not differentiate between different types of organizational performance, the second study (#2) investigates the relationship between IT and organizational agility as a specific type of business value.

*Table A-1. Overview of studies included in the thesis*

| No | Outlet | Ranking | Status | Section | Core research question |
|---|---|---|---|---|---|
| #1 | Journal of the Association of Information Systems * | A | Passed 1st round of review | B.I | How can contradictory findings on the relationship between inter-organizational IT factors and business value be resolved? |
| #2 | International Conference on Information Systems 2016 | A | Published | B.I | How can contradictory findings on the relationship between IT and organizational agility be resolved? |
| #3 | Information and Organization | B | Submitted | B.II | How can the relational view be reconceptualized and extended when applied to the context of information systems? |
| #4 | Journal of Information Technology | A | 2nd round of review | B.II | What is the role of inter-organizational IT alignment as a dynamic capability for co-creating value? |
| #5 | European Conference on Information Systems 2016 | B | Published | B.III | How does IT-enabled collaboration lead to supply chain performance under environmental uncertainties in supply chains in the wood industry? |
| #6 | Pacific Asia Conference on Information Systems 2017 | C | Published | B.III | How do IT capabilities lead to resource efficient production in supply chains in the wood industry? |

*Note: The ranking is based on the VHB Jourqual 3 ranking.*
** Study #1 has already been published in the Proceedings of the European Conference on Information Systems 2016 (VHB ranking: B) and was nominated for the best paper award.*

**Part B.II** focusses on the second research question, and extends theoretical findings on IT-based value co-creation mechanisms by explaining the key capabilities and interdependencies in order to capture IT-related phenomena in the context of inter-organizational networks. Both studies target executives in regional networks, and thus a unit of analysis independent from the industrial context. The first study (#3) extends and reconceptualizes the relational view by providing new IT constructs and reconfiguring the underlying logic of this theory. The second study (#4) investigates the role of inter-organizational IT alignment as a dynamic capability and, therefore, as a primary source for co-creating value.

**Part B.III** addresses the third research question and aims to adapt the theoretical findings on IT-based value co-creation mechanisms to the specific context of the wood industry. Therefore, both studies address organizations in the wood sector. The first study (#5) aims to examine how IT-enabled collaboration leads to supply chain performance under different dimensions of environmental uncertainties. The second study (#6) sheds light on the business value dimensions of supply chains in the wood industry, and elaborates how dynamic IT capabilities lead to resource efficient production – a construct that has been newly developed for this investigation.

**Part C** ("Contributions") completes the thesis. As a first step, the findings from the six studies on IT-based value co-creation in inter-organizational networks are reflected and integrated. Synthesizing the findings across all studies, an extended theory on IT business value generation is developed, and a holistic view of reference theorizing is provided. Following this, implications for research and practice are outlined. Finally, the limitations of this thesis are addressed, and an outlook for future research directions is given.

## I.4 Research Context

This research is conducted within the context of the Research Training Group (RTG) 1703 "Resource Efficiency in Interorganizational Networks"[1], which focuses on the development of methods for the design and optimization of resource-efficient value networks for renewable raw materials. Its novelty lies in the integration of various disciplines, such as material science, marketing, operations research, and information systems research, to comprehensively analyze effective cascade utilization of inter-organizational networks along the whole supply chain. Accordingly, the RTG is composed of three interrelated topical groups: Material Sciences (A) investigates industrial production processes in the wood industry, Operative Planning (B) focuses on planning algorithms and efficient logistic systems, and Governance (C) examines inter-organizational networks from the perspectives of marketing and information management.

In the context of the RTG 1703 (see Figure A-3), this thesis especially builds on and extends the findings of the studies from Trang (2015) and Zander (2017). Both works found that a number of inter-organizational IT capabilities (e.g., IT integration, knowledge sharing, and IT-enabled collaboration) positively impact business value in the wood industry. Up to now, it has yet remained unclear how these capabilities relate to each other regarding the capability-building process to create business value. Therefore, this thesis aims to integrate and extend reference theories to derive a theoretically founded explanation of the key capabilities and interdependencies of IT-based value co-creation mechanisms. Moreover, these mechanisms are subsequently

[1] The Research Training Group was funded by the German Research Foundation (DFG; Deutsche Forschungsgemeinschaft) from 2012 to 2016.

adapted to the special context of the wood industry. Furthermore, this thesis extends the business value dimensions, which have previously been limited to relational IT value and supply chain performance. Firstly, organizational agility is introduced as a further business value dimension in order to take into account that inter-organizational networks need to respond to dynamically changing environments. Secondly, business value is elaborated in the context of the wood industry by adding resource efficiency as a further outcome dimension.

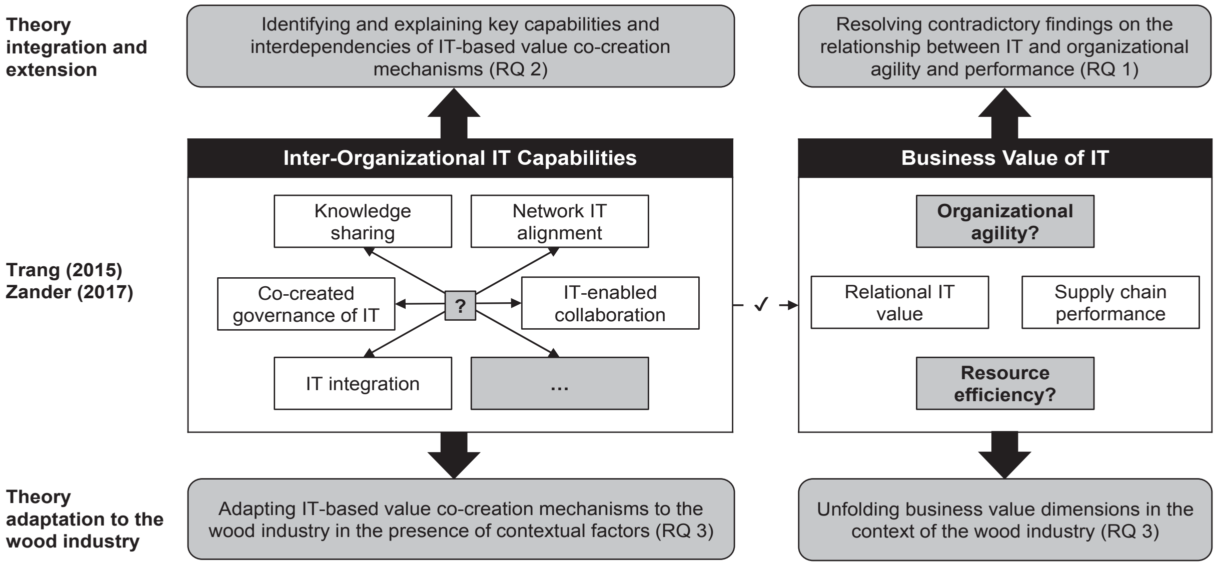


*Figure A-3. Relation of the thesis to the findings within the RTG 1703*

In accordance with the above, this thesis contributes primarily to the topical group C ("Governance, Coordination and Distribution"). Apart from this main focus, the results are related to other disciplines of the RTG, too. For instance, the assessment of resource efficiency as a business value dimension relates to the characterization of intermediate products from the timber industry. Moreover, the findings are relevant for operative planning, i.e., algorithms for multi-criteria optimization and computer-based production planning in recycling cascades.

## I.5 Research Design

This thesis primarily occupies a position in the academic discipline of information systems research, that "focuses on how IT systems are developed and how individuals, groups, organizations, and markets interact with IT" (Sidorova et al. 2008, p. 475). In particular, following Banker and Kauffman (2004), it is positioned within two IS research streams. First, the thesis addresses the stream of *Economics of IS* by examining the impact of IS on business value. Second, since IT capabilities are investigated as mechanisms for value creation, it is also located in the stream of *IS organization and strategy*. Due to the interdisciplinary nature of IS research (Palvia et al. 2004; Wilde and Hess 2007) and the applied reference theorizing approach, this thesis is also closely related to the disciplines of strategic management and operations management (OM).

The IS discipline distinguishes between two complementary but distinct research paradigms, i.e., design oriented and behavior oriented research (Hevner et al. 2004). *Design science* stems from engineering, and focuses on the creation and evaluation of artifacts that provide problem-oriented solutions for IS-related issues (March and Storey 2008; Wilde and Hess 2007). In contrast, *behavioral science* is rooted in natural science, and develops and justifies theories with the aim of explaining human and organizational issues in the development, management, and usage of IS and IT (Hevner et al. 2004). As this thesis aims to explain and predict how inter-organizational networks co-create business value when utilizing information technology, and to integrate, extend, and adapt theories, it primarily follows the behavioral research paradigm. Nevertheless, the extended theories and developed constructs can provide a foundation for future design-oriented solutions.

In terms of epistemological positioning, i.e., the assumptions that affect the construction and evaluation of knowledge, three types of paradigms are distinguished in IS research: positivism, interpretivism, and critical reality (Gregor 2006; Orlikowski and Baroudi 1991). *Positivistic* research assumes an objective world that is independent from the researcher and aims to derive knowledge by verifying or falsifying generalizable theories (Orlikowski and Baroudi 1991; Wynn and Williams 2012). In contrast, *interpretive* research believes in a subjective world which is constructed by and dependent of the social actors. Therefore, theory is constructed from the field, taking subjectivity into account (Orlikowski and Baroudi 1991). Lastly, the *critical* research position assumes an independent reality that is, however, socially and historically constructed and not fully observable (Mingers et al. 2013; Wynn and Williams 2012). This thesis explains causal relationships in IT-based value co-creation by integrating, extending, and adapting theories, which are ultimately tested in generalizable samples. It, therefore, can be assigned to the epistemological positioning of positivism.

Both the research paradigm and epistemological positioning influence the appropriateness of the research methodologies. As this thesis follows a behavioral positivistic approach, it employs the typical methodologies of “boxes-and-arrows” by testing causal relationships with *quantitative methods*, i.e., statistical inference and multivariate analyses (Lee and Hubona 2009). However, to obtain divergent and complementary views of the phenomena and to utilize the strengths of multiple methods, this thesis also employs *qualitative methodologies* (e.g., literature analyses and semi-structured interviews), resulting in a mixed-method approach (Venkatesh et al. 2013). The research paradigms, research designs, and theoretical foundations of the studies included in this thesis are summarized in Table A-2.

*Table A-2. Overview of research paradigms, research designs, and theoretical foundations of studies included in the thesis*

| No | RQ | Paradigm | Data collection | Data analysis | Theorization | Related theories |
|---|---|---|---|---|---|---|
| #1 | 1 | Behavior oriented | Observations in quantitative studies *(N = 33,732)* | Meta-analysis | Integration | Resource-based view, Relational view |
| #2 | 1 | Behavior oriented | Observations in quantitative studies *(N = 7,646)* | Meta-analysis | Integration | Resource-based view, Dynamic capability theory |
| #3 | 2 | Behavior oriented | Cross-sectional survey *(N = 152)* | Structural equation modeling | Extension | Relational view, Embedded view of IT, Concept of appropriation |
| #4 | 2 | Behavior oriented | Cross-sectional survey *(N = 241)* | Structural equation modeling | Extension | Dynamic capability theory, IT capability framework, Strategic alignment model |
| #5 | 3 | Behavior oriented | Cross-sectional survey *(N = 150)* | Structural equation modeling | Adaptation | Resource-based view, Organizational information processing theory, Relational view |
| #6 | 3 | Design oriented / behavior oriented | Semi-structured interviews *(N = 10)* Content validation by experts *(N = 13)* Cross-sectional survey *(N = 242)* | Exploratory interview analysis, structural equation modeling | Adaptation | Resource-based view, Dynamic capability theory |

Scholars distinguish between three genres of theorizing in IS research (Grover and Lyytinen 2015). While novel theories are built from scratch in *Blue Ocean theorizing*, *data-driven theorizing* refers to research that inductively interprets new empirical data. In addition, *reference theorizing* is defined as the adoption of theories from external (reference) disciplines to explain and predict IS phenomena (Moody et al. 2010). According to Grover and Lyytinen (2015), reference theorizing can be further classified into three types: *Instantiation* is characterized by the application of the reference theory to a particular context by making no or only minor changes to the reference theory. *Modification* describes the changing of a theory's constructs or logic in order to adapt the theory to a specific context. *Extension* refers to adding new constructs, relationships, and logic to the reference theory in order to more appropriately capture context-specific phenomena.

Inspired by Grover and Lyytinen (2015), this thesis offers and follows a three-step reference theorizing approach to understand, explain, and predict IT-based value co-creation in inter-organizational networks. This is reasoned as follows. A negative consequence of conventional reference theorizing in IS research lies in the incommensurate and contradictory findings resulting from adapting a general theory to a unique context (Grover and Lyytinen 2015). Yet, meta-analyses have been found to be an appropriate approach for resolving such drawbacks by integrating research findings across studies, and providing “building blocks” for further theory construction (Hunter and Schmidt 2004). Accordingly, the first step of the reference theorizing approach used in this thesis is the **integration** of extant research studies to resolve their contradictory results. Building on this, the second step comprises the **extension** of reference theories by developing and adding new constructs, configurations, and logic in order to properly capture unique phenomena in the IS context. Finally, the third step involves the **adaptation** of the extended theories to the specific context of the wood industry by instantiating and modifying their constructs and relationships to account for the underlying contextual conditions and to increase the practical relevance.

## I.6 Anticipated Contributions

This cumulative thesis aims to advance the understanding of the co-creation of value by IT in inter-organizational networks. Therefore, the results target several audiences in both research and practice (see Table A-3).

*Table A-3. Overview of anticipated contributions*

| | Audience | Anticipated Contribution |
|---|---|---|
| Research | Information systems | • Resolving contradictory findings on IT business value creation in inter-organizational networks<br>• Explaining IT-related phenomena of value co-creation in inter-organizational networks<br>• Understanding how IT can co-create value under the specific contextual conditions in the wood industry<br>• Extending IT business value research to inter-organizational networks<br>• Enriching the “Mid-Range” theory in IS research |
| Research | Strategic management | • Extending the understanding of reference theories by blending them with insights from IS research |
| Research | Operations management | • Integrating the notion of IT capabilities in the value creation process of operational capabilities and performance<br>• Developing new conceptualizations and measurement instruments for the value dimension |
| Practice | Decision-makers across industries | • Providing recommendations on how to allocate IT resources in inter-organizational networks to co-create value<br>• Identifying key IT capabilities needed for achieving favorable outcomes from collaboration in inter-organizational networks |
| Practice | Decision-makers in the wood industry | • Providing insights into the industry-specific circumstances that affect the value of inter-organizational IT investments<br>• Supporting the identification and quantification of IT-related outcomes |

This thesis is positioned within IS literature in the first place, and consequently aims to advance knowledge in this research discipline. In particular, it is positioned within the stream of IT business value research and more specifically within IT-based value co-creation. IT business value research examines the impact of IT on organizational performance (Melville et al.

2004), thus fulfilling at least two conditions (Kohli and Grover 2008): 1) investigating an IT variable or manifestation and 2) conceptualizing an endogenous variable with economic impact. Research on IT-based value co-creation investigates IT business value at the inter-organizational level of analysis, showing how multiple firms can create value through joint IT investments (Grover and Kohli 2012). This thesis seeks to advance knowledge in this field by offering three major contributions. First, it aims to resolve contradictory findings of previous studies by drawing on reference theories and taking contextual conditions into account. Second, it intends to advance the understanding of IT-based value co-creation mechanisms by extending corresponding theories from reference disciplines. Third, this thesis aims to shed light on the contextual conditions that affect IT value generation in inter-organizational networks in the specific context of supply chains in the wood industry. Beyond providing insights on the specific phenomenon of IT-based value co-creation, this thesis also aims to advance knowledge and to extend theory on IT business value in general (Kohli and Grover 2008; Masli et al. 2011; Melville et al. 2004; Schryen 2010) by expanding the level of analysis to inter-organizational networks.

Furthermore, this thesis aims to advance knowledge in the field of operations management. The OM and IS literature are increasingly intertwined, which is, for example, highlighted in the special issue on IT and supply chains in the Journal of OM (Venkatesh 2013). Accordingly, a number of studies have been published in IS journals (e.g., Ayabakan et al. 2017; Rai et al. 2006; Wang et al. 2013) and OM journals (e.g., Chen et al. 2013; Liu et al. 2016; Wong et al. 2015) that address both research streams. This thesis aims to contribute further to a synthesis between both disciplines by developing new constructs and measurement instruments for the business value dimension in manufacturing firms, i.e., in the wood industry, and integrating IT concepts in this value creation process.

A reference theorizing approach (see Section A.I.5) is utilized to realize the anticipated theoretical contributions. Borrowing grand theories from reference disciplines represents a common approach in IS research, which is yet increasingly criticized for a lack of theoretical insights and for treating the IT artifact as exogenous to theorizing (Avison and Malaurent 2014; Grover and Lyytinen 2015; Hassan and Lowry 2015). By extending reference theories in order to investigate IT-specific phenomena of value co-creation, this thesis seeks to advance theoretical insights for the IS community. Therefore, it aims to contribute to “Enrich the Mid-Range Theory” (Grover and Lyytinen 2015, p. 288). On the other hand, the findings also advance knowledge in the reference discipline, i.e., strategic management, from which the theories are borrowed. Accordingly, this thesis contributes to calls for utilizing a two-way theory blending approach (Grover and Lyytinen 2015; Oswick et al. 2011).

Finally, as IS research in general (e.g., Lee 1999; Straub and Ang 2011) and IS behavioral research in particular (e.g., Gill and Bhattacherjee 2009; Gregor and Hevner 2013) have been criticized for a lack of practical relevance, this thesis also aims to provide direct recommendations for practitioners. In particular, it addresses decision-makers and managers who aim to realize superior benefits by making joint IT investments with their network partners. By unfolding the mechanisms of IT-based value co-creation in inter-organizational networks, the findings of this thesis, thus, provide insights on recommended managerial actions, and on how managers should allocate inter-organizational IT resources to create favorable outcomes. Moreover, the practical relevance is increased by adapting the results to a specific industrial context (Robey and Markus 1998; Rosemann and Vessey 2008). Accordingly, this thesis also targets decision-makers in the wood industry. The value co-creation mechanisms are instantiated in a more specific context, which reduces the level of abstraction for practice and provides insights on the industry-specific contextual conditions that need to be considered. Furthermore, this thesis aims to support executives in identifying and quantifying outcomes of inter-organizational IT investments by developing corresponding measurement instruments.

# II. Theoretical Background

As outlined in the previous sections, this cumulative thesis seeks to deepen the understanding of how IT can lead to value in inter-organizational networks. This chapter presents an overview of the related theoretical foundations and research findings. First, an understanding of inter-organizational networks as an economic form of organization is provided. The subsequent section discusses theoretical concepts of and findings on IT-based value co-creation. Finally, an overview of the wood industry, including its networks and IT support, is given. To avoid redundancies with the studies in Part B, this chapter gives a comprehensive overview of the major theoretical concepts and contextual conditions, whereas more detailed literature analyses can be found in the respective studies (see Part B).

## II.1 Foundations of Inter-Organizational Networks

Network forms of organization are not a new phenomenon. Records of collaboration between multiple organizations go back as far as hundreds of years ago, for example to the networks of the Medici in Florence in the 15th century (Padgett and Ansell 1993). Networks have gathered increased attention in research and practice since the 1970s due to increased globalization and an intensified focus on core competencies, having led to an increase in their number and diversity (Hage and Alter 1997; Siebert 2003). However, scholars do not always have a clear and common understanding when using the term “network”, sometimes also referring to similar terms, such as partnerships, alliances, or interfirm relationships (Provan et al. 2007). Therefore, the following paragraphs aim to provide a basic understanding of inter-organizational networks for this thesis, including their theoretical foundations, types, and outcomes.

From the transaction cost perspective, a network is characterized as an organizational form that is contrasted with market and hierarchy (Powell 1990; Thorelli 1986; Williamson 1991). In *market* (or arm’s length) transactions, independent firms perform transactions on the basis of contracts and prices. The relationships between the parties are characterized by competition and a high level of flexibility and volatility (Thorelli 1986). In contrast, *hierarchy* describes functional and vertical integration of organizational entities. This mode of organization is coordinated through a high level of control and authority, which is typical for firms (Williamson 1991). *Network* types of organization denote an intermediate or hybrid organizational form between market and hierarchy, representing reciprocal patterns of exchange between companies (Powell 1990). Although networks have – to some extent – attributes from both markets and hierarchies, they are typically regarded as a separate type of economic organization (Powell 1990). Initially, research characterized networks as the supplementary option of partnering in addition to the choice between make or buy (Barringer and Harrison 2000). More recently, scholars and practitioners have recognized networks as an independent and important type of organizational governance and coordination (Provan and Kenis 2007).

Following the perspective of networks as an alternative form to markets and hierarchies, inter-organizational networks have two main characteristics. First, in contrast to arm's length relationships, inter-organizational networks *cooperate* to achieve common goals (Provan and Kenis 2007). Consequently, although network partners may have different and conflicting individual goals, they are subordinate to the collective objectives of the network (Powell 1990). Therefore, collaboration such as joint research and production of goods or services is a key aspect of inter-organizational networks (Alter and Hage 1993; Hage and Alter 1997). Second, in contrast to hierarchal forms of organization, inter-organizational networks consist of organizations that are *economically and legally independent* (Camarinha-Matos and Afsarmanesh 2008). This implies flexibility and commitment of network partners, contrary to hierarchical structures like business groups, mergers and acquisitions, and multi-unit firms (Siebert 2003). It should be noted that intense cooperation may result in economic dependencies between the network partners, for example, in high degrees of the share of wallet. However, the relationship is still characterized by independency in terms of resource heterogeneity (Lavie 2006). Summarizing both characteristics, inter-organizational networks are defined as an organizational form composed of legally and economically autonomous organizational entities that cooperate to achieve common goals (Camarinha-Matos and Afsarmanesh 2008; Provan and Kenis 2007).

The term inter-organizational network is a broad one, encompassing a variety of network types with different attributes. Taking the types of inter-organizational networks into consideration is important as it influences the way in which network partners cooperate and create value, and allows for comparability with previous research studies (Sydow 2003). Research has identified various attributes that characterize different types of inter-organizational networks, such as the type of interdependency (Van de Ven et al. 1979), the number of participants (Hollingsworth 1991), or the physical distance between network members (Hage and Alter 1997). Sydow (2003) proposes a typology of inter-organizational networks that fits the network types investigated in the studies of this thesis. The typology is based on two dimensions. First, the *network structure* can be classified into hierarchical and heterarchical structures. While one or a few organizations lead the network in a hierarchical structure, decisions are made equally in heterarchical networks. Second, inter-organizational networks can be distinguished by the *degree of stability*, i.e., stable versus dynamic networks. Both dimensions lead to a two-dimensional matrix, including four types of inter-organizational networks (see Figure A-4).

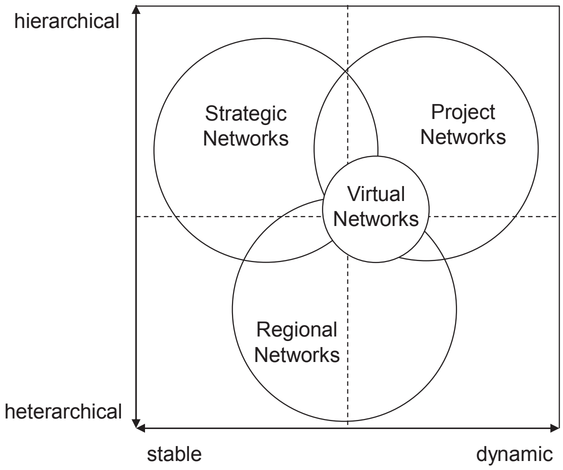


*Figure A-4. A typology of inter-organizational networks (Sydow 2003)*

According to the above classification, s*trategic networks* are characterized by rather formalized relationships, where often, one or more focal organizations strategically lead the network (Sydow 2003). Supply chains are the most typical and frequently investigated example of strategic networks, and are characterized by coordinated, long-term, and rather static than dynamic structures (Camarinha-Matos and Afsarmanesh 2008). This type of network involves "upstream and downstream flows of products, services, finances, and/or information from a source to a customer" (Mentzer et al. 2001, p. 4). Companies in the consumer-related position of the supply chain typically perform strategic leadership in those networks such as, for example, being observed in the automotive industry (Sydow 2003). In contrast to strategic networks, r*egional networks* are defined by their common agglomeration area and local proximity, often organized in clusters (Bell et al. 2009; Sydow and Duschek 2011). In this context, a cluster refers to "a geographically proximate group of interconnected companies and associated institutions" (Porter 2000, p. 254). As regional networks typically lack hierarchical control, they are characterized by the importance of emergent strategy and inter-organizational trust (Provan and Kenis 2007; Sturm et al. 2004). Further, *project networks* are formed for the execution of inter-organizational projects and, therefore, differ from strategic and regional networks in their temporal existence (Sydow 2003). Although these networks, therefore, are typically organized in hierarchical structures led by one company, they may also exist as ad-hoc networks without an explicit structure (Camarinha-Matos and Afsarmanesh 2008; Sydow 2003). Finally, *virtual networks* are mostly temporary alliances of collaborating organizations which are enabled and supported by networked IT (Camarinha-Matos and Afsarmanesh 2008). This type of inter-organizational network can exist in hierarchical and heterarchical structures.

Outcomes of inter-organizational networks, i.e., performance in terms of competitive advantage, are critical issues in network research (Provan et al. 2007). Assuming that inter-organizational networks differ from the market forms of organization, Dyer and Singh (1998) argue that networks realize competitive advantages only because they differentiate the relationship from the attributes of arm's length relationships. Thus, networks aim to generate competitive advantages in terms of relational rents that typical market relationships are unable to generate. Relational rent refers to "a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners" (Dyer and Singh 1998, p. 662). The fundamental mechanism beyond the generation of relational rents is the sharing and synergetic combination of resources and capabilities between firms.

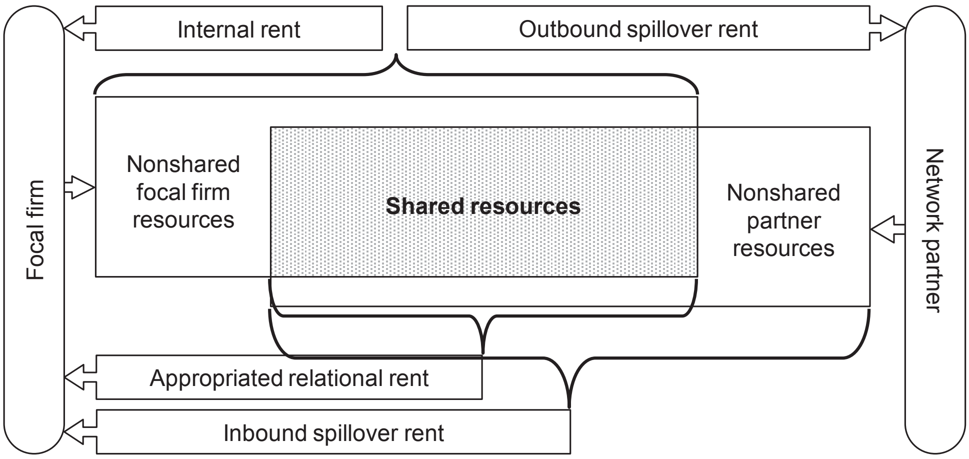


*Figure A-5. Composition of relational rents extracted in inter-organizational networks (Lavie 2006)*

Figure A-5 shows the composition of relational rents in inter-organizational networks, subsuming four different types (Lavie 2006). First, *internal rents* are generated from the scarcity (Ricardian rents) and specialization (quasi-rents) of both interfirm and intrafirm resources. The resulting benefits, however, are exclusively absorbed by the focal firm. Next, inter-organizational networks can create *appropriated relational rents*, which result only from the shared resources of both network partners. While contractual agreements and a small scale and scope of resource determine ex-ante rents, absorptive capacity and reduced opportunistic behavior are factors of ex-post appropriated relational rents. Third, *inbound spillover rents* are exclusively derived from the shared and non-shared resources of network partners. These benefits are usually unintended and facilitated by opportunistic behavior and bargaining power. Finally, *outbound spillover rents* result from the opposite direction, referring to unintended access to the resources of a focal firm that benefits the network partners.

## II.2 Foundations of IT-Based Value Co-Creation

An ultimate objective of investments in IT is the improvement of organizational performance (Palmer and Markus 2000). However, many studies in the 1980s were unable to find a connection between IT investments and organizational performance. This has come to be known as the "Productivity Paradox of IT" (Brynjolfsson 1993), highlighted by Solow's (1987) statement that "we see the computer age everywhere except in the productivity statistics" (cited in Brynjolfsson 1993, p. 67). Although many studies and practical examples showed the relevance of IT in enhancing performance, opposite positions questioned the value of IT, even going as far as making statements like "IT doesn't matter" (Carr 2003). The stream of IT business value research originates from this paradox, examining the economic impact of IT (Kohli and Grover 2008). IT-based value co-creation represents a relatively young research field and a substream of IT business value research (Kohli and Grover 2008). Although co-creation substantially differs from business value generation in single firms due to its multi-organizational perspective, many theoretical concepts have their origins in intra-organizational research on IT business value. Moreover, this thesis aims to extend theory on IT business value to an inter-organizational level of analysis. Therefore, this section first provides the theoretical foundations of IT business value research, before proceeding with basic concepts of IT-based value co-creation.

Strategic management analyzes the competitive advantage of firms from an external and internal perspective (Spanos and Lioukas 2001). The first perspective considers a firm's industry structure as the primary force of performance, concluding that firms realize competitive advantage by obtaining privileged market positions (Henderson and Mitchell 1997). The dominant paradigm in this perspective is built on the work of Porter's competitive strategy framework (Porter 1980). In contrast, the resource-based view (RBV) focuses on the internal perspective, arguing that the unique resources of a firm are the central source of competitive advantage (Teece et al. 1997). This perspective has been specified and formalized by Barney

(1991, p. 101), who defines resources as “all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enables the firm to conceive of and implement strategies that improve its efficiency and effectiveness”. The perspective is based on two major assumptions, namely resource *heterogeneity*, i.e., resources are differently distributed among firms, and resource *immobility*, i.e., difficulties in imitating and substituting resources by competitors. Based on this assumption, valuable, rare, inimitable, and non-substitutable resources lead to sustained competitive advantage (Barney 1991). Consistent with previous research (Rivard et al. 2006), this thesis adapts the perspective of the RBV for analyzing IT business value generation, while focusing on the industry structure in form of contextual factors in the wood industry (see Section A.II.3).

Transferring the RBV to the IS context, IT-related resources encompass tangible resources, i.e., the physical IT infrastructure, human IT resources, including the technical and managerial IT skills, and IT-enabled intangibles, such as IT-related knowledge and synergy (Bharadwaj 2000). IT resources typically do not meet the underlying assumptions of the RBV, i.e., heterogeneity and immobility. It is argued that especially technical IT resources are not heterogeneously distributed as they can be easily acquired on the market (Mata et al. 1995). Moreover, in contrast to other resources, IT resources are seen as imperfect mobile and easy to imitate, for example, by hiring expertise via the labor market or consulting firms (Powell and Dent-Micallef 1997; Wade and Hulland 2004). Therefore, IT resources per se are not seen as a source of competitive advantage. In contrast, research has explained the value generation effect of IT by the notion of capabilities. Following this view, capabilities refer to the ability of an organization to integrate, mobilize, and utilize resources, usually in combination with other resources and capabilities (Grant 1991). Scholars, therefore, argue that the value of IS results from its synergistic combination with other, non-IS related resources and capabilities (Mata et al. 1995; Ray et al. 2005; Wade and Hulland 2004). IT capabilities are accordingly defined as “the ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities” (Bharadwaj 2000, p. 171). Under these circumstances, research widely recognizes that IT enhances business value (Kohli and Devaraj 2003; Sabherwal and Jeyaraj 2015).

IT business value can manifest itself in multiple dimensions (Kohli and Grover 2008; Masli et al. 2011; Schryen 2013). Traditionally, researchers argue that the immediate value of IT can be observed in improved operational efficiency of specific business processes, which then results in overall organizational performance (Melville et al. 2004). Organizational performance measures include market performance, such as Tobin's q, and accounting performance, e.g., return on assets (ROA) and return on sales (ROS). Moreover, IT value manifests itself in intangible and non-financial value dimensions, such as customer satisfaction and the quality of supplier relationships. It should be noted that IT business value neither necessarily implies competitive advantage, i.e., how the firm performs in relation to its competitors, nor sustainability in terms of an enduring nature of value. Although research showed the valuable role of IT in this context, different measures and more advanced IT capabilities are required to both assess and achieve sustained competitive advantage (Bhatt and Grover 2005; Kohli and Grover 2008).

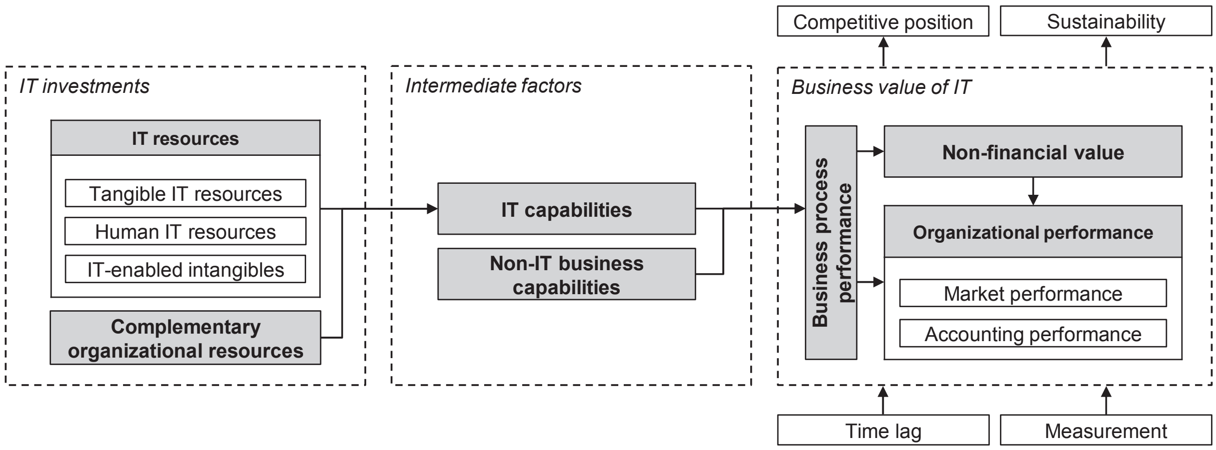


*Figure A-6. Synthesis of IT business value research (adapted from Kohli and Grover 2008; Masli et al. 2011; Melville et al. 2004; Schryen 2013)*

Figure A-6 summarizes previous knowledge on IT business value, showing that the productivity paradox seems to be resolved. Accordingly, IT does create value in various dimensions by building capabilities through synergistically complementing other IS and organizational resources (Kohli and Grover 2008). Moreover, diverging results stem from the inappropriate use of measurement and analysis methodologies (Kohli and Devaraj 2003; Sabherwal and Jeyaraj 2015), time lag effects (Santhanam and Hartono 2003), and the complexity in isolating effects of IT (Kohli and Grover 2008).

Research on IT-based value co-creation extends IT business value research to an inter-organizational level of analysis, examining how multiple firms with different IT jointly create superior value (Grover and Kohli 2012). Following the perspective of resources and capabilities, inter-organizational systems represent underlying IT-related resources in inter-organizational networks. This thesis adopts the definition by Johnston and Vitale (1988, p. 154), referring to IOS as "built around information technology, i.e. around computer and communications technology that facilitates the creation, storage, transformation, and transmission of information. An IOS differs from an internal, distributed information system by allowing information to be sent across organizational boundaries" (Johnston and Vitale 1988, p. 154). Besides technical facets, IOS also comprise human and task-related aspects, distinguishing this term from inter-organizational IT (Heinrich et al. 2011). IOS perform the following tasks: information sharing, communication, collaboration, transaction, and coordination (Riemer and Klein 2006).

Extended to inter-organizational networks, inter-organizational IT capabilities are defined as the mobilization and deployment of IOS in combination with complementary resources and capabilities to execute inter-organizational business activities (Bharadwaj 2000; Rai et al. 2012). Inter-organizational networks accordingly contribute similar or distinct resources to the network, which are then utilized and combined with complementary interfirm resources and capabilities to co-create value (Sarker et al. 2012). Grover and Kohli (2012) propose four mechanisms of IT-based value co-creation. First, network partners can provide relation-specific *assets*, leading to jointly created digital products and services. Second, value can be co-created through *knowledge sharing* by developing data and process standards. Third, inter-organizational networks utilize IT functionalities that interact with *complementary capabilities* of the network partners for value co-creation. Finally, network members manage and integrate their relationships through network *governance*, thereby leading to IT-enabled cost reduction.

## II.3 An Overview of the Wood Industry

Due to its societal and economic relevance as well as its need to derive value from inter-organizational IT investments, the wood industry represents an appropriate case for adapting the research findings of this thesis to a specific industry context. Therefore, this section first gives an overview of the industry structure and the characteristics of the inter-organizational networks, followed by the current state of inter-organizational IT support in this sector.

### II.3.1 Inter-organizational networks in the wood industry

Following the classification of inter-organizational networks presented in Section A.II.1 (see Figure A-4), organizations in the wood industry are organized in regional clusters consisting primarily of small and medium-sized enterprises (SMEs) (Kies et al. 2010). Additionally, as the industry is featured by processing wood resources and materials across the value chain, it also has characteristics of a supply chain, i.e., a strategic network (D'Amours et al. 2009). This thesis follows the common understanding originated from the European Union that the wood industry comprises all sectors that have a direct link to wood resources (Becher and Weimar 2016). Accordingly, this industry encompasses various subsectors, including the manufacturing and processing of wood, pulp, paper, paperboards, furniture, sawmilling and planning, printing and related activities (Eurostat 2008). In 2014, the over 125 thousand companies working within the German wood industry employed more than one million employees, which is comparable to the automotive industry (Statista 2017). Furthermore, they accounted for an annual turnover of about 177 billion Euros (Becher 2016).

Figure A-7 shows an overview of the material and product flows in the wood industry. The networks of organizations encompass the whole value chain – from the production of roundwood downstream the value chain over wood processing (e.g., pulp production and sawmills) to the production of finished products (e.g., furniture and paper products) downstream the value chain. Moreover, wood resources and residues are used for energy purposes, i.e., in private households and biomass power plants. The processing of wood is also characterized by reversed logistics and cascade utilization. For example, recovered wood from construction sites (e.g., solid beams) can be utilized for smaller timber products (e.g., lamellas) first, which after time can serve as fiberboards, before finally being energetically recovered (Höglmeier et al. 2017). The utilization of renewable resources like wood clearly requires holistic optimization across the entire inter-organizational network to optimize resource and material usage while minimizing waste (Narodoslawsky 2003). Accordingly, organizations in the wood industry establish close relationships in the form of regional networks (Frank and Nagel 2009).

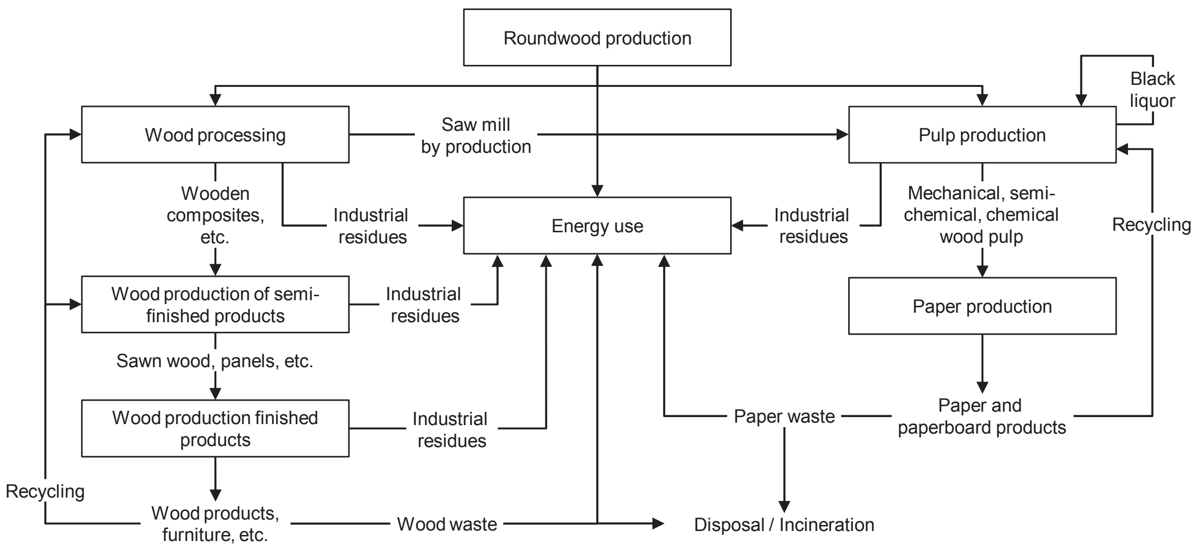


*Figure A-7. An overview of resource flows in the wood industry (adapted from Mantau 2011)*

The processing of wood is typically associated with uncertainties regarding resource availability, quality, price, and source (Ludorf 2015), corresponding with the aim of realizing a high level of cascade utilization. Therefore, wood processing networks aim to optimize the efficient use of wood resources (Geldermann et al. 2016), which is also underlined by the high costs of wood waste and increasing environmental awareness in this sector (Daian and Ozarska 2009). Resource efficiency denotes the minimization of the amount of resources, i.e. natural, industrial, and waste-as-resources, to achieve a given level of output (Duflou et al. 2012; Huysman et al. 2015). It differs from the concept of eco-efficiency, which refers to the minimization of environmental impacts, in its ultimate goal of achieving performance outcomes (Dahlström and Ekins 2005).

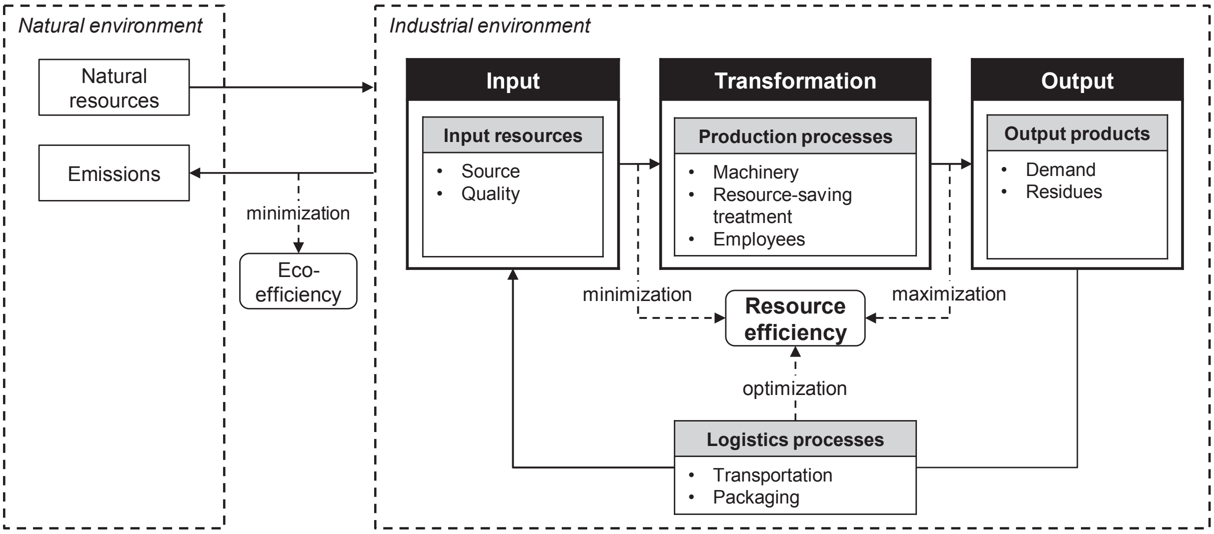


*Figure A-8. An input-output approach to resource efficiency (adapted from Huysman et al. 2015; Tangen 2004)*

As shown in Figure A-8, resource efficiency can be conceptualized as a multi-dimensional concept based on the input-output approach, encompassing the entire process of transforming raw materials into finished products (Huysman et al. 2015; Modi and Mishra 2011). First, resource efficiency is reflected by the *input resources* of the production processes, i.e., regarding the source and quality of the input materials (Despeisse et al. 2013). For example, optimized timber lengths and cutting patterns delivered as materials for furniture manufacturers can lead to a more efficient use of wood resources (Schliephake et al. 2009). Second, the level of resource efficiency depends on the efficiency of the *production processes*. For instance, automated cutting machines or the use of computerized numerical control (CNC) machines can improve the efficient use of wood resources in the manufacturing processes (Daian and Ozarska 2009). Moreover, the efficiency of production processes is reflected in the resource-saving treatment (e.g., temperature and light incidence) of materials (Ardente and Mathieux 2014), product defects resulting in resource losses (Chompu-Inwai et al. 2015), and the behavior of the employees (Ardente and Mathieux 2014). Third, resource efficiency is embedded in the *output products* of the production processes. Wood waste is reported to generate high costs for companies in this industry and, therefore, its minimization and increased recycling enhances efficiency (Eshun et al. 2012). Moreover, imbalances in demand and supply, e.g., resulting from the bullwhip effect, can cause inefficient use of resources (Lee et al. 1997). Finally, resource efficiency extends the boundaries of a firm by being determined by *efficient logistics processes* in the supply chain (Veleva and Ellenbecker 2001). As such, the utilization of packaging materials and transport methods especially influences the consumption of resources (Grant et al. 2010).

### II.3.2 Inter-organizational IT support in the wood industry

The scattered sources of wood due to changing harvest areas, different delivery and ordering processes, and changing network actors increase the complexity of collaborating in inter-organizational networks in the wood industry. This complexity and the need to reduce transaction costs and maintain the competitive position requires the utilization of IOS (Blattert et al. 2012). Accordingly, different types of IOS were specifically developed for the needs of the wood industry. An example is the logistics software *IFIS UNO*, which supports data exchange, supply chain functions, integrated communication, and reporting functions to facilitate collaboration. It is provided as software-as-a-service (SaaS) via the Internet (Lemm and Thees 2009).

IT standards provide an important foundation for IOS in order to electronically link network partners (Blattert et al. 2012). For example, a saw mill and a pulp mill need to agree on their joint business processes (e.g., delivery mode), understand the content of the order or delivery, and exchange messages with a prescribed communication protocol to effectively interact through IOS (Azouzi and D'Amours 2011). Although a wide range of national and international IT standards for wood-related industries exist, the four standards depicted and compared in Figure A-9 seem to be especially relevant for the German wood industry (Blattert et al. 2012).

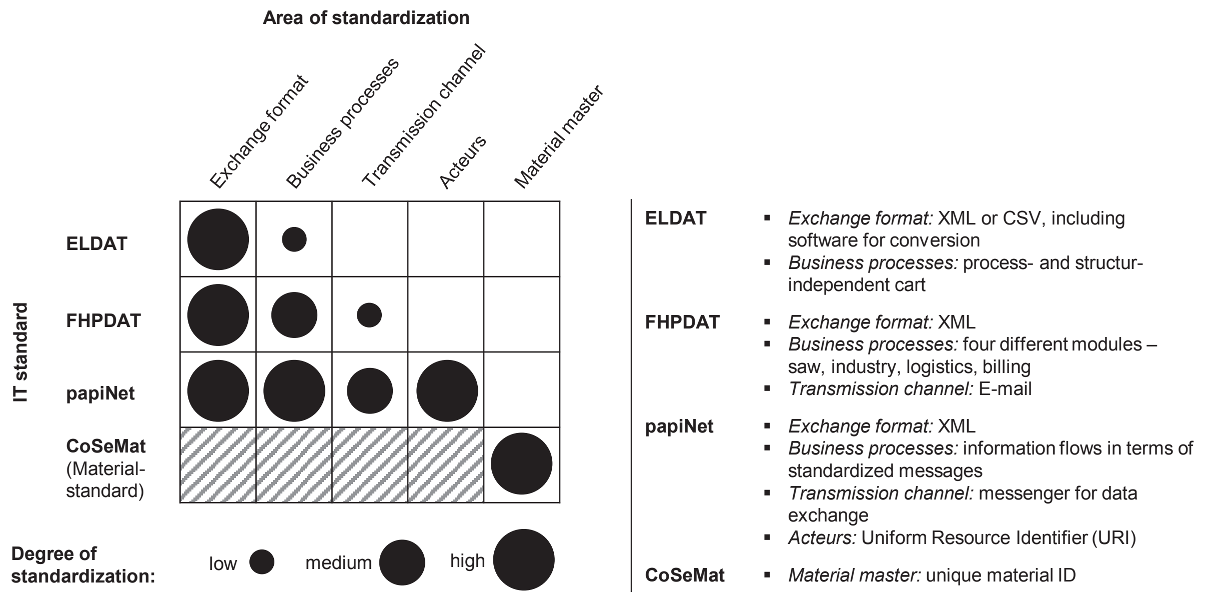


*Figure A-9. An overview of IT standards in the wood industry (Blattert et al. 2012)*

*ELDAT* (*Elektronischer Datenaustausch Holzdaten*) is a data interface for the exchange of wood-related product and contractual data in the German wood industry, especially between saw mills, timber trade companies, and forest owners (Azouzi and D'Amours 2011; Nick 2010). The standard is implemented via the exchange of comma-separated value (CSV) or Extensible Markup Language (XML) files. Next, the Austrian standard *FHPDAT* is comparable to *ELDAT*, but focuses more on the standardization of business processes by encompassing four modules, i.e., saw, industry, logistics, and billing. Moreover, it specifies the transmission channel (Blattert et al. 2012). While *ELDAT* and *FHPDAT* have a focus on German-speaking countries, the standard *papiNet* is internationally oriented. It is characterized by a higher level of complexity and standardization as it specifies a modular system for standardizing business documents and related business processes. Moreover, it uses the ebXML messaging service for communication between network partners (Azouzi and D'Amours 2011). Lastly, *CoSeMat* (*Common-sense-material master*) represents solely a material standard, aiming to clearly identify wood materials by various attributes, e.g., species of tree, quality, and category. It is compatible with the standards *ELDAT* and *FHPDAT* (Blattert et al. 2012).

Although a variety of IOS and corresponding standards for the wood industry exist, this sector is characterized by a low diffusion of IT in general and IOS in particular, compared to more mature sectors, such as the banking or automotive industry (Arano and Spong 2012; Hewitt et al. 2011; Trang et al. 2014). For example, Hewitt et al. (2011) conducted a literature review on 17 IT adoption studies in the North American wood industry and concluded that these companies "have been slow in integrating IT into their business" (Hewitt et al. 2011, p. 167).

More recent studies have reported that although a majority of companies among the US forest products manufacturers at least use websites and email, advanced e-commerce and social media functions like online sales and marketing are not widely adopted by these companies (Montague et al. 2016). One argument is that industry-specific characteristics, such as the relatively high average age of staff and low governmental support, affect IOS adoption in this industry (Zander et al. 2015b). Nevertheless, it has been shown that IOS can be beneficial for companies cooperating in the wood sector. For example, Gazal et al. (2016) report that social media and e-commerce applications can lead to benefits, such as increased exposure, branding, and lead generation, for forest products companies. Moreover, it has been demonstrated that tracking and tracing systems can reduce costs (Appelhanz et al. 2016) and decrease energy consumption as well as negative environmental impacts (Taskhiri et al. 2013) along the supply chain in the wood industry. Other possible benefits include the optimization of resource allocations (Uusijärvi et al. 2010), higher acceptance of sustainable products (Osburg et al. 2016), and reduced negative environmental impacts through route optimization (Hug 2004). Furthermore, it has been shown that the development of inter-organizational IT capabilities can lead to value for organizations in the wood industry in terms of supply chain performance (Zander 2017).

# B. Studies on IT-Based Value Co-Creation in Inter-Organizational Networks

The overall goal of this thesis lies in deepening the understanding of how value can be co-created through IT in inter-organizational networks, addressing three related research questions. According to the reference theorizing approach followed to answer these research questions (see Section A.I.5), this chapter is divided into three sections, namely theory integration (B.I), theory extension (B.II), and theory adaptation (B.III).

Initially, Section B.I aims to resolve contradictory existing research findings by theory integration. Accordingly, this section includes Studies #1 and #2, which integrate the findings of previous research by drawing on reference theories and considering contextual factors. Subsequently, Section B.II aims to examine key capabilities and interdependencies of IT-based value co-creation by extending the reference theories within the scope of two studies. While Study #3 reconceptualizes and extends the relational view, Study #4 relates to dynamic capability theory in the context of inter-organizational IT alignment. Finally, Section B.III seeks to analyze value co-creation in the specific context of the wood industry by theory adaptation, including two studies. Study #5 investigates the role of environmental uncertainties as contextual factors, and Study #6 analyzes resource efficient production as a business value dimension. Summarizing, the six studies result in a reference theorizing perspective on IT-based value co-creation in inter-organizational networks, and a theoretical foundation for extending IT business value theory to the inter-organizational level of analysis.

# I. Theory Integration: Resolving Contradictory Results of Research on IT Business Value Creation in Inter-Organizational Networks

This chapter aims to answer the first research question. The focus is on resolving inconsistent and contradictory findings in the field of IT business value generation in inter-organizational networks by drawing on reference theories and analyzing contextual factors. Following the reference theorizing approach used in this thesis, this aim is pursued by means of theory integration. Accordingly, previous research studies across different industries represent the unit of analysis.

Two meta-analyses have been conducted to explain contradictory findings on two relationships that are particularly relevant for organizations cooperating in inter-organizational networks. First, Study #1 analyzes the relationship between inter-organizational IT factors and business value of IT at and across multiple level of analysis. The resource-based view and relational view are adopted as reference theories, and a number of methodological and contextual factors are considered. Study #2 focuses on explaining inconsistent findings on the impact of IT on organizational agility. This study adopts the perspectives of the resource-based view and dynamic capability theory, while analyzing adaptive and entrepreneurial agility as value dimensions, and considering the study's attributes as contextual factors.

# 1 Study #1: Meta-Analysis of IT-Based Value Co-Creation[2]

*Table B-1. Fact sheet of Study #1*

| | |
|---|---|
| Title | Synthesizing and Integrating Research on IT-Based Value Co-Creation: A Meta-Analysis |
| Authors | Markus Mandrella, mmandre@uni-goettingen.de[*]<br>Simon Thanh-Nam Trang, strang@uni-goettingen.de[*]<br>Lutz M. Kolbe, lkolbe@uni-goettingen.de[*]<br>[*]Georg-August-Universität Göttingen<br>Chair of Information Management<br>Platz der Göttinger Sieben 5<br>37073 Göttingen |
| Outlet | Journal of the Association of Information Systems (JAIS), 1st submission, Completed Research Paper |
| Abstract | Recently, competition has shifted from the firm to the network level. Following this path, a growing stream in IT value research has emerged, aiming to understand how multiple firms create value through joint IT resources and capabilities. Despite the efforts made thus far, there are inconsistencies regarding construct definitions and divergent empirical findings. In this paper, we synthesize and integrate the body of knowledge on IT-based value co-creation. Drawing on the relational view, we first synthesize the existing empirical findings. The results of a meta-analysis of 72 studies encompassing 33,732 observations underline the importance of four sources of IT value: IT-based inter-organizational assets, IT-based knowledge sharing, IT-based complementary capabilities, and IT-based governance. A further moderator meta-analysis integrates divergent empirical findings in the literature. We find that objective measures dampen the relationship between inter-organizational IT and business value, while process-level measures and IT capabilities strengthen it. Moreover, we find evidence for higher value impacts in developing countries and an influence of inter-organizational relationship types. This study contributes by clarifying the IT-business value relationship and offers insights into sources of inconsistencies in IT-based value co-creation studies. By doing so, this paper lays a foundation for future research and theory development. |
| Keywords | Value co-creation; Relational view; IT value; Inter-organizational IT; Meta-analysis; Review |

[2] Study #1 has already been published in the Proceedings of the European Conference on Information Systems 2016 (VHB ranking: B) and was nominated for the best paper award.

## 1.1 Introduction

With advancements in information technology, research and practice continues to investigate how value can be derived from IT. This is becoming an even greater challenge as contemporary organizations cooperate more regularly in interfirm relationships. Inter-organizational systems (IOS), e.g., eBusiness systems, electronic data interchange (EDI), and supply chain systems, improve interfirm coordination and communication, increase innovation, and facilitate knowledge sharing (Chi and Holsapple 2005). By combining such IT resources and developing interfirm capabilities, firms can co-create superior benefits and synergies (Grover and Kohli 2012). However, this also results in new issues for IT value generation due to heterogeneous strategies, information systems, and capabilities that must be integrated among firms (Rai et al. 2012). Furthermore, it is difficult to capture and manage the distribution of co-created value (Kohli and Grover 2008).

Research on IT value evaluates the economic impact of IT (Kohli and Grover 2008). It is a research field of contradictory findings, which has come to be known as the productivity paradox of IT (Brynjolfsson 1993). To explain these inconsistencies in research findings, much effort has been recently placed into synthesizing IT value research through literature reviews and framework development (Kohli and Grover 2008; Masli et al. 2011; Melville et al. 2004; Schryen 2010; Yassaee and Mettler 2015) as well as meta-analyses (Kohli and Devaraj 2003; Sabherwal and Jeyaraj 2015). At this point, researchers generally agree that IT does create value and that the contradictory findings have been a result of time lag and measurement issues as well as contextual and intermediate factors. Research on IT-based value co-creation investigates how multiple firms can create value via joint IT resources and capabilities, resulting in challenges such as the level of analysis, new value-creation mechanisms, and methodological approaches (Grover and Kohli 2012). To address these challenges, research on IT-based value co-creation has been garnering increased attention. The importance of this research area has been addressed, for example, by recent publications on IT value (Kohli and Grover 2008; Masli et al. 2011; Sabherwal and Jeyaraj 2015) and the 2012 MIS Quarterly special issue on co-creating IT value (Grover and Kohli 2012).

Despite the great efforts made in furthering IT-based value co-creation research during recent years, we observe several inconsistencies in the literature: First, although research has explored a wide variety of interfirm IT factors that contribute to business value, there exist various definitions and concepts. For example, many studies refer to IS integration but are related to different concepts, such as infrastructural (Saraf et al. 2007), information (Barua et al.

2004), or IT-enabled process integration (Rai et al. 2015). Second, there are contradictory findings regarding the impact of inter-organizational IT on business value, such as those concerning the value of investments in EDI systems (e.g., Dröge and Germain 2000; Truman 2000). Third, studies investigate business value at different levels of analysis and dimensions, diminishing the comparability of results. Fourth, different methodological and value-measurement approaches as well as underlying contextual factors, such as the type of relationship, might affect the studies' results. Such inconsistencies limit our understanding of how value can be co-created through IT. Therefore, a systematic analysis is necessary to explain how the structural characteristics of IT-based value co-creation studies influence business value. This will help to critically review past studies in this research field as well as facilitate future research and theory development.

The aim of this study is therefore to synthesize and explain contradictory findings of the growing research on IT-based value co-creation. To do so, we aim to answer the following research questions: (1) Which inter-organizational IT factors lead to business value in what magnitude? (2) To which business value dimensions does inter-organizational IT lead? (3) How do the study's methodological and contextual attributes affect the relationship between inter-organizational IT and business value?

To answer these research questions, we conducted a meta-analysis of 66 quantitative publications, 72 studies and over 33,000 observations. We built on the relational view of the firm (Dyer and Singh 1998) as well as the related IT-based value co-creation framework developed by Grover and Kohli (2012) and analyzed four sources of relational value: (1) IT-based inter-organizational assets, (2) IT-based knowledge sharing, (3) IT-based complementary capabilities, and (4) IT-based governance. We investigated the extent of business value resulting from these sources and how they differ among different value dimensions: (a) firm level vs. relational level and (b) process level vs. organizational level. Furthermore, we examined whether variation across studies depends on methodological and contextual factors. This resulted in a research model with hypotheses based on theory and previous findings. In addition, we conducted explorative analyses where no a priori expectation was given. Such data-driven research initiates future theory development (Hambrick 2007) and is increasingly called for by IS researchers (e.g., Grover and Lyytinen 2015).

The remainder of this paper is structured as follows. First, we define the constructs and moderators identified in IT-based value co-creation research and derive the study's research model. We then introduce the research design including the data collection, coding procedure, and statistical analysis. Afterwards, we discuss the results in light of the current body of IT-based value co-creation literature, address limitations, and offer an outlook for further research. The study closes with a conclusion.

## 1.2 Research on IT-Based Value Co-Creation

We follow the definition of IT value research by Kohli and Grover (2008), in which economic outcomes and/or IT-related factors are investigated at the inter-organizational level of analysis. Therefore, our focus lies on research that satisfies the following conditions: (1) IT-based variable or manifestation, (2) endogenous variable with an organizational IT economic impact, and (3) at least one of the first two conditions lies at an interfirm level of analysis.

Figure B-1 summarizes the research model. In the following, we define the structural dimensions of the studies and develop hypotheses regarding the impact on business value.

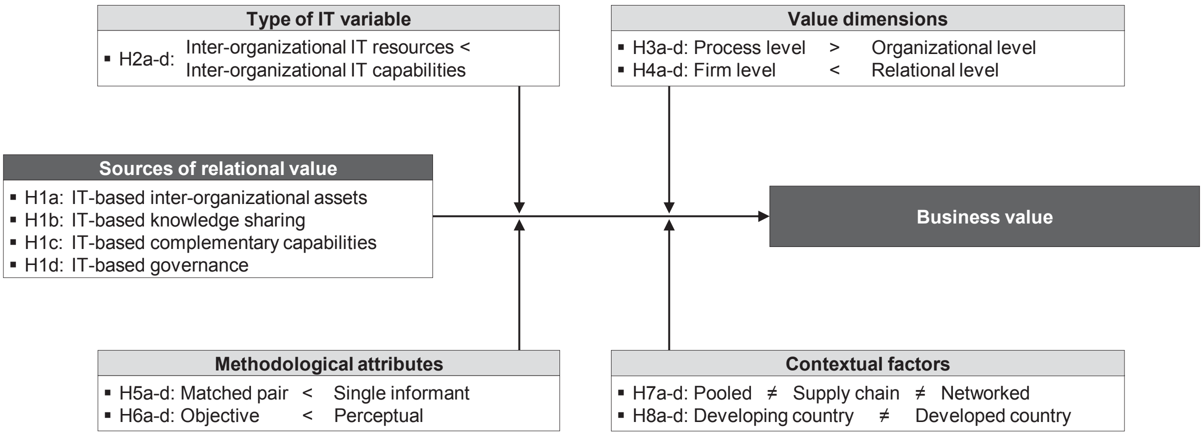


*Figure B-1. Research model of IT-based value co-creation*

### 1.2.1 IT-based sources of relational value

Based on the relational view of the firm (Dyer and Singh 1998), Grover and Kohli (2012) propose four sources of business value from inter-organizational IT. The relational view states that a firm's resources and capabilities may span its boundaries. By combining resources and capabilities in a unique way and creating idiosyncratic interfirm linkages, firms can create relational value - supernormal profits they could not attain on their own. Dyer and Singh (1998) assume four main sources of relational value: (1) interfirm relation-specific assets, (2) knowledge-sharing routines, (3) complementary resources and capabilities, and (4) effective governance. All these sources can be created, expanded, or enabled by inter-organizational IT (Grover and Kohli 2012). In the following, we analyze each of these IT-based sources and how they contribute to relational value. The construct definitions are provided in Table B-2.

*Table B-2. Construct definitions of the IT-based sources of relational value*

| Construct | Definition | Examples |
|---|---|---|
| IT-based inter-org. assets | IT assets and IT personnel that are specialized to the relationship and enable digital connections in interfirm relationships. | IT integration, IOS adoption, eBusiness capabilities, use of operations support systems |
| IT-based knowledge sharing | Knowledge and information exchange based on IOS that enable information processing capabilities. | Data connectivity, electronic inf. sharing, online information capabilities, IOS visibility |
| IT-based complementary capabilities | IT functionalities that synergistically complement each other and enable the technical ability to identify, exploit, and leverage complementary capabilities and resources. | IT reconfiguration, analytic ability of IOS, IT-enabled intangibles, IT leverage competence |
| IT-based governance | The facilitation of coordination, planning, control, and decision making through IOS. | E-cooperation, IT-enabled collaborative decision making, IT-enabled planning and control |

First, we distinguish between inter-organizational IT resources and IT capabilities. IT resources refer to “commodity-like assets that are widely available and can be purchased from the factor market” (Wang et al. 2012, p. 328). They encompass IT-related technological assets and human resources (Bharadwaj 2000; Ray et al. 2005). Inter-organizational IT resources can be related to a certain source of relational value, e.g., partner interface–directed information systems for knowledge sharing (Malhotra et al. 2005) and operations management systems as relation-specific assets (Bardhan et al. 2007). Furthermore, they encompass general inter-organizational IT infrastructure. In IT-based value co-creation research, IT resources are assessed in terms of three concepts: (1) investments in IOS, (2) adoption of IOS, and (3) functionalities of IOS. On the other hand, IT capabilities are defined as the “ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities” (Bharadwaj 2000, p. 171). In the context of value co-creation, inter-organizational IT resources are used in combination with the four sources of the relational view to perform interfirm business activities (Rai et al. 2006), e.g., the analytical ability of IOS to leverage complementary capabilities (Lee and Wang 2013) and effective governance via electronic cooperation (Choi and Ko 2012). In literature, this is assessed through IT-based factors that reflect (1) the actual use of IOS for relational sources and (2) the enabling role of IOS for relational sources.

Relation-specific IT resources describe IT assets and IT personnel that are specialized for the relationship (Grover and Kohli 2012). Research has examined IT resources that relate to the interfirm IT infrastructure, such as integration (e.g., Bharadwaj et al. 2007; Rai et al. 2006; Saraf et al. 2007), interoperability (Zhao and Xia 2014), and customization (Klein and Rai 2009). Furthermore, several studies have investigated investments in IOS in general (e.g., Hadaya and Cassivi 2012) as well as its adoption (da Silveira and Cagliano 2006). As a capability, IT-based relation-specific assets enable digital connections in interfirm relationships in the form of interfirm process integration as well as new products and services (Grover and Kohli 2012; Rai et al. 2015); eBusiness capabilities (Devaraj et al. 2007; Zhu et al. 2015) are such an example. We argue that IT-based inter-organizational assets lead to business value for the following reasons: First, as relation-specific resources and capabilities, they foster idiosyncratic linkages and make further value-creating initiatives economically viable (Hadaya and Cassivi 2012; Saraf et al. 2007). Second, through the automation of interfirm business processes, they reduce transaction costs and uncertainties by, for example, reducing both paperwork as well as communication errors (Im and Rai 2014; Rai et al. 2015). Third, new business opportunities, such as access to new markets and improved customer satisfaction, can arise (Barua et al. 2004; Zhu and Kraemer 2005). Therefore, we propose a first hypothesis:

**H1a:** IT-based inter-organizational assets are positively related to business value.

Business value can also be co-created through knowledge sharing based on IOS, such as knowledge repositories or common databases (Grover and Kohli 2012). At the resource level, this includes investments in and the adoption of specific IOS for both knowledge-sharing (Malhotra et al. 2005) and information-sharing functionalities of IOS, such as data connectivity and availability (Zhao and Xia 2014). At the capability level, information-processing capabilities are embedded in interfirm processes to, for example, provide tactical information on demand (Barua et al. 2004). The relational view argues that firms can co-create value by developing the absorptive capacity to recognize, assimilate, and apply information to partner firms (Dyer and Singh 1998). Inter-organizational systems allow one to deal with large amounts of data and thus provide the infrastructural basis for absorptive capacity (Barua et al. 2004; Wong et al. 2015). Furthermore, the reduction of technical barriers and seamless access to data initially leads to increased, more efficient, and more visible information flows among network partners (Barua et al. 2004; Roberts and Grover 2012). Therefore, we propose that:

**H1b:** IT-based knowledge sharing is positively related to business value.

Complementary IT resources describe IT functionalities that synergistically complement each other, whereas IT capabilities in this context refer to the technical ability to identify, exploit, and leverage complementary capabilities and resources of partner firms (Grover and Kohli 2012). Quantitative IS research has paid less attention to this source of value. However, existing studies (e.g., Jeong et al. 2009; Rai et al. 2012; Subramani 2004) indicate that IT-based complementary capabilities lead to business value. Because of greater connectivity and communication through IOS, firms can leverage partner resources that are not available on the market (Hadaya and Cassivi 2012; Zhu and Kraemer 2002). For example, firms complement their IT capabilities to develop a platform that integrates knowledge about customers, leading to superior and synergetic value effects (Sarker et al. 2012). Therefore, we propose the following:

**H1c:** IT-based complementary capabilities are positively related to business value.

IT-based governance in interfirm relationships refers to the facilitation of coordination, planning, control, and decision making through IOS and leads to business value for the following reasons: First, the relational view argues that informal and self-enforcing governance mechanisms are more effective than formal arrangements (Dyer and Singh 1998). IT-based governance resources and capabilities serve as safeguards, resulting in less opportunistic behavior and more intense collaborative management of relationships (Grover and Kohli 2012; Lee et al. 2014; Wang et al. 2013). Second, due to more frequent interactions, IT-based governance leads to an improved decision-making and planning process in interfirm relationships (Wang et al. 2013). Therefore, we propose the following:

**H1d:** IT-based governance is positively related to business value.

Grounded in the resource-based view, it is argued that IT resources can be imitated by competitors because they are mobile in nature and widely available on the market (Mata et al. 1995; Wade and Hulland 2004). Therefore, IT resources per se do not necessarily lead to business value. In contrast, IT capabilities are developed over time, embedded within an organization and its processes, and therefore difficult to transfer and to imitate (Barua et al. 2004; Rai et al. 2012). Under these conditions, researchers agree that IT does create business value. Although research has shown that inter-organizational IT resources are necessary conditions for value co-creation (e.g., Hadaya and Cassivi 2012) and also have direct effects on business value (e.g., Dröge and Germain 2000), we argue that inter-organizational IT capabilities have an even greater impact on business value. However, as interfirm relationships are rather complex – with multiple partners having heterogeneous strategies and cultures – they are more difficult to organize and manage (Barringer and Harrison 2000). Hence, IT must meet the specific challenges that arise from the network context, which can be achieved by developing unique inter-organizational IT capabilities (Saraf et al. 2007; Subramani 2004). Therefore, we propose our second hypothesis:

**H2a-d:** Inter-organizational IT capabilities have a greater impact on business value than inter-organizational IT resources do.

### 1.2.2 Business value dimensions

The business value of IT can manifest itself in several different dimensions. Traditionally, researchers distinguish between the impacts of IT on organizational or process business value (Kohli and Grover 2008; Melville et al. 2004; Schryen 2010). Organizational business-value measures encompass market, accounting, and relationship value. Process value measures assess the efficiency of specific business processes, such as ordering and customer processes. Researchers widely agree that IT first impacts business process performance, where improvements lead to overall organizational performance (Dehning and Richardson 2002; Ray et al. 2005; Schryen 2010). This especially applies to interfirm relationships because inter-organizational IT fosters the integration and synthesis of business processes (Melville et al. 2004; Rai et al. 2006). In contrast, performance measures at the firm or relationship-wide level are influenced by numerous other factors, possibly weakening the impact of IT resources and capabilities (Davamanirajan et al. 2006; Dehning and Richardson 2002). Therefore, we propose for all IT-based sources of relational value (a-d) the following hypothesis:

**H3a-d:** IT-based sources have a greater impact on process value than on organizational value.

Research on IT-based value co-creation can be further referred to on different levels of analysis, i.e., the firm or relational level (Straub et al. 2004). At the firm level, organizational outcomes are analyzed independently from the interfirm relationship. In contrast, relational value aggregates firm-level outcomes to relation-specific outcomes, such as network returns on interest. Furthermore, relation-specific value can be assessed at the firm level, but as a result of the interfirm relationship and vice versa (Provan and Kenis 2007). Similar to H3, we argue that the impact of the four IT-based sources on business value will be greater if it is assessed at the specific domain of investigation (Davamanirajan et al. 2006; Zhu 2004). In the context of value co-creation, the four IT-based sources first impact relational value, which in turn leads to value for the individual firms (Chang and Shaw 2009). In contrast, business value at the firm level is also affected by intra-organizational IT resources and capabilities, along with other factors. Furthermore, value can be shared unequally among firms (Grover and Kohli 2012). Therefore, we propose a fourth hypothesis:

**H4a-d:** IT-based sources have a greater impact on relational value than on firm-level value.

### 1.2.3 Methodological moderators

The means of measurement is a major issue in IT value research (Chan 2000). We first analyze the type of respondents: data can be collected from a single informant or by matching responses from two individuals in different firms but with the same relationship. Because single informants may not have adequate knowledge about the relationship as a whole and over- or underestimate the variables – especially in asymmetric relationships – matched pair surveys tend to be more reliable (John and Reve 1982; Ryoo and Kim 2015) and can also reduce common method bias (Tallon and Pinsonneault 2011). However, matched pairs compromise the anonymity of the survey (Kearns and Sabherwal 2007) and are especially difficult to conduct in different firms (Duffy 2008), leading to measurement errors (Gerow et al. 2014). Because of the bias of single respondents and in accordance with other IS topics (e.g., Gerow et al. 2014), we argue that using single respondent types will result in larger estimates of business value:

**H5a-d:** IT-based sources have a greater impact on business value in studies that use single respondent types.

Second, measurement of IT value can be classified into two types: objective and perceptual (Chau et al. 2007). Although objective measures tend to be more reliable, perceptual measures are better suited to the study's context and variables of interest (Chau et al. 2007; Sabherwal and Jeyaraj 2015). Because of methodological challenges and a lack of information on the companies surveyed, it is even more difficult to find or develop appropriate measures at an inter-organizational level of analysis (Straub et al. 2004). Therefore, we propose the following:

**H6a-d:** IT-based sources have a greater impact on business value in studies that use perceptual measures.

### 1.2.4 Contextual variables

The importance of relationship attributes in the context of IT-based value co-creation has been highlighted by various studies (e.g., Grover and Saeed 2007; Rajaguru and Matanda 2013). Therefore, we analyze the type of relationship as a contextual variable. Kumar and van Dissel (1996) distinguish three types of interdependencies among firms: First, in a pooled interdependency, multiple firms use and share common resources. Second, in supply chain interdependencies, the output from one firm becomes the input for another firm; this is the most investigated type of relationship in IS research, e.g., buyer–supplier relationships. Third, firms collaborate in mutual exchange and interactively in networked interdependencies, such as in collaborative alliances. Researchers argue that the impact of certain IOS differs among these relationship types (Chi and Holsapple 2005; Kumar and van Dissel 1996). Hence, we expect variations in the magnitude of the relationship between the four IT-based sources and business value. However, there are no theoretical foundations regarding the impact of IT resources and capabilities derived from the relational view. Therefore, we have no a priori hypotheses and propose non-directional hypotheses for this contextual variable:

**H7a-d:** The relationship between IT-based sources and business value differs among studies with pooled, supply chain, and networked relationship types.

Lastly, we investigate the role of the economic region in terms of developing and developed countries. It is argued that firms in developing countries have less access to the resources, skilled labor, and technological infrastructure required to develop IT capabilities (Shih et al. 2008). In contrast, regulatory support and minimal competitive pressure (Zhu and Kraemer 2005) as well as the high potential of IT capabilities for improvement (Piatkowski 2006) might foster IT-based value co-creation in developing countries. Previous studies on IT value have revealed contradictory findings regarding the role of the economic region (e.g., Patrakosol and Lee 2009; Sabherwal and Jeyaraj 2015). Therefore, we propose another non-directional hypothesis:

**H8a-d:** The relationship between IT-based sources and business value differs among studies conducted in developing and developed countries.

## 1.3 Meta-Analysis

This study employs a meta-analysis to test the main effect of IT-based sources on business value. A meta-analysis partition test is then used to assess the moderating effects of the types of IT variables, different value dimensions, methodological attributes, and further contextual factors.

Meta-analysis is a statistical method that systematically aggregates the quantitative results of primary studies and, in doing so, allows for a higher statistical power for the measures of interest (King and He 2005; Rosenthal 1991). This methodology is particularly suitable for this analysis because it not only enables us to integrate findings of previous studies in a rigorous and quantitative fashion but also allows us to analyze the effects of context-dependent factors. Through this, we can explain the differences among studies and consolidate contradictory findings on the IT-business value relation.

The research design comprises three basic steps. First, we collected quantitative papers on IT value in inter-organizational settings that cover the relation between IT and value variables. In the second step, we used these papers to extract a database of studies and calculated a quantitative measure (“effect size”) for the IT-business value relations. The studies were then coded for the variables of interest, i.e., the type of the IT variable (resource or capability), different value dimensions, methodological attributes, and further contextual factors. This database constitutes the basis for the following statistical analysis for detecting and assessing the moderators.

### 1.3.1 Data-collection procedure

The meta-analysis starts with the identification of prior studies that report sufficient data on the association between IT and business value in interfirm relationships. Our procedure for data collection includes searches through scientific databases as well as for studies from prior meta-analyses, which is consistent with the recommendations of Hunter and Schmidt (2004) and other IS meta-studies (Gerow et al. 2014; Kohli and Devaraj 2003; Sabherwal and Jeyaraj 2015; Wu and Lederer 2009).

Publications were collected between August and October 2015. We began our search for such studies in Business Source Complete (EBSCOhost), ScienceDirect (ELSEVIER), and the Association for Information Systems Electronic Library (AISeL). The papers included in the analysis were identified using keywords such as “value co-creation”, “relational value”, and “IT value” in conjunction with terms such as “inter-organizational”, “inter-firm”, “collaborative network”, “corporate network”, “cluster”, and “alliance.” The search results were first screened to determine whether they contained a quantitative empirical study with an IT value focus. We used prior meta-analyses on IT value as an additional source of studies, screening the studies used in Kohli and Devaraj (2003), Sabherwal et al. (2006), and Sabherwal and Jeyaraj (2015) for those that study interfirm relationships. We explicitly included conference publications and studies that had no double-blind reviews in our search results to counteract the file drawer effect (Rosenthal 1979), which refers to the tendency of journals to preferentially publish significant results, thereby biasing the results if only journals are considered for the analysis (Dickersin 1990).

We only sought out studies that provide sufficient information for the subsequent statistical analysis, particularly the information necessary to derive an effect size for the IT-business value relation, sample size, and a precise description of the study’s context. This data was essential for the following coding procedure. When publications reported several studies based on independent data sets, they were treated as different studies. When studies included several IT or business value variables, and thus important relationships, they were coded in one of two ways: If the difference between the variables was relevant for the subsequent coding procedure, they were added to the database as separate relationships.[3] However, if the difference between the variables was determined to be important, they were arithmetically averaged (Hunter and Schmidt 2004).

The final sample comprises 66 publications, including 72 studies and 126 IT-business value correlations, all of which were published between 1999 and 2015. Together, there was a total of 33,732 different observations. The full list of studies can be found in the Appendix.

### 1.3.2 Coding of studies and measurement of variables

The coding procedure began with gathering data for the IT value relation. To measure the effect size of this relationship, we coded for the correlation between IT and business value. If a study did not directly report this information, we applied the method described in Hunter and Schmidt (2004) for correcting study artifacts (see Appendix E in Wu and Lederer, 2009). The coding procedure for each study also included capturing information for the following variables. (1) *Source of relational value*: The IT variable of each correlation entry was categorized according to the four IT-based sources of relational value (see Table B-2): IT-based inter-organizational assets, IT-based knowledge sharing, IT-based complementary capabilities, and IT-based governance. (2) *Type of IT variable*: A correlation for the variable “resource / capability” was coded as a resource if the IT variable is measured by investments in, adoption of, and functionalities of IOS. In contrast, if the IT variable is assessed by the actual use of IOS for relational sources or the enabling role of IOS for relational sources, the correlation entry was coded as inter-organizational IT capability. (3) *Value dimensions*: A correlation was coded for the variable “process level / organizational level” according to the business variable of each study. The variable captures process outcomes (e.g., operational excellence) or organizational outcomes (e.g., improved financial performance). The variable “firm level / relational level” was coded according to where the business value is measured, whether at the firm level (e.g., return on assets) or at the relationship level (e.g., supplies chain performance). (4) *Methodological attributes*: The variable “matched pair / single informant” captures whether the data for both the IT and the business value is collected from a single respondent, while

[3] Please note that for the later calculations, the sample sizes for these entries have been corrected. However, what we refer to as “observation” is still the sum of individual observations across the studies.

"objective / perceptual" was coded for the information on how the business variables are measured, either as objective indicators (e.g., return on investments) or perceptual statements (e.g., perceived alliance performance). (5) *Contextual factors*: The variable "pooled / supply chain / networked" was coded according to the inter-organizational business relation under study. This categorization follows Kumar and van Dissel's (1996) understanding of different types of interdependencies. The variable "developing country / developed country" was coded according to the sample of each study (International Monetary Fund 2015).

### 1.3.3 Data analysis and results

This study follows the widely applied Hedges and colleagues' method for conducting fixed effects meta-analyses (Hedges and Olkin 1985; Hedges and Vevea 1998). We first converted the effect sizes into a standard normal metric using Fisher's z-transformation and then weighted these scores with each study's sample size, allowing us to account for differences in measurement errors.

The results of the meta-analysis are displayed in Table B-3 and give support for the direct effects of all four sources of relational value (H1a–d). All sources are significantly different from zero. Considering the confidence intervals, the data suggest that IT-based governance has the strongest influence, followed by IT-based knowledge sharing, IT-based complementary capabilities, and IT-based inter-organizational assets. To check the robustness of these findings, we computed Orwin's fail-safe N statistics (Orwin 1983), which display the number of non-significant publications that would be required to reduce the estimated effect size to a trivial level. For hypotheses H1a–d, the fail-safe N clearly exceeds the number of studies, indicating that unpublished and non-significant studies are not a threat for our analysis. Moreover, one study has a sample size of 14,065, which clearly exceeds the others. We checked if this single study might have biased the results. A re-estimation without this study did not change the significant positive influence as well as the order of the hypotheses.

*Table B-3. Results of the meta-analysis*

| Hypothesis | # corr. | # observations | Est. correlation | Std. err. | Z-value | Confidence interval (.95) | Orwin's fail-safe N | Variance | Credibility interval (.80) |
|---|---|---|---|---|---|---|---|---|---|
| H1a: IT-based inter-org. assets | 72 | 25,713 | .146 | .006 | 23.636 ** | .134 – .158 | 139 | .032 | -.084 – .377 |
| H1b: IT-based knowledge sharing | 24 | 3,593 | .308 | .017 | 19.072 ** | .278 – .337 | 124 | .179 | .079 – .537 |
| H1c: IT-based compl. capabilities | 16 | 4,654 | .235 | .015 | 16.351 ** | .208 – .262 | 59 | .040 | -.020 – .490 |
| H1d: IT-based governance | 14 | 1,589 | .423 | .025 | 17.991 ** | .382 – .463 | 104 | .025 | .220 – .626 |

***Notes:*** *# corr. = number of correlations; Std. err. = the standard error of the point estimators; Confidence interval = computed at an 95% level, Orwin's fail-safe N = assumption of a criterion correlation of .05, calculated as #studies * (est. correlation - criterion correlation) / criterion correlation; Variance = the variance in the distribution of the effect sizes; Credibility interval = computed at an 80% level; indications for significance: ** p < .01, * p < .05, and* $^{n.s.}$ *p > .05.*

We computed credibility intervals for the search of moderators (Hunter and Schmidt 2004). It is a measure for the posterior distribution of the effect sizes before correcting for measurement errors. A wide interval or an interval that includes zero indicates that effect sizes originate in different subpopulations. The effect sizes of all four sources were revealed to have large credibility intervals (>.40) or include zero correlations. Accordingly, moderating effects should be suspected.

The moderating hypotheses were tested using a partition test (King and He 2005). The studies were split into subgroups relating to the moderator variable being examined. As a next step, a meta-analysis was calculated separately for the subgroups. The resulting weighted average Z-values were then compared using a Z-test (Hedges and Olkin 1985). The results are depicted in Table B-4.

We find empirical support across all four sources of IT-based relational value for the type of IT variable (H2) and the objective vs. perceptual measurement of the value variable (H6). The data also gives evidence for the hypothesis that developed countries differ from undeveloped ones for three value dimensions (H8). The data suggest that developing countries profit even more from IT. However, due to insufficient data, the hypothesis for IT-based complementary capabilities could not be evaluated (H8c). We found partial support for the value dimensions (H3 and H4) and the network type (H7) but no support for differences between matched pair and single informant measurements (H5).

*Table B-4. Results of the moderator meta-analysis*

| Hypothesis | a. IT-based inter-org. assets | | | | b. IT-based knowledge sharing | | | | c. IT-based compl. capabilities | | | | d. IT-based governance | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | # corr. | # obs. | est. corr. | Z-value (support) | # corr. | # obs. | est. corr. | Z-value (support) | # corr. | # obs. | est. corr. | Z-value (support) | # corr. | # obs. | est. corr. | Z-value (support) |
| **H2: Inter-organizational IT resources < Inter-organizational IT capabilities** | | | | | | | | | | | | | | | | |
| Inter-org. IT resources | 45 | 14,995 | .097 | 9.584 ** | 12 | 1,866 | .213 | 6.333 ** | 9 | 3,635 | .158 | 10.408 ** | 3 | 425 | .235 | 5.094 ** |
| Inter-org. IT capabilities | 27 | 10,718 | .215 | (Yes) | 12 | 1,727 | .404 | (Yes) | 7 | 1,019 | .484 | (Yes) | 11 | 1,164 | .484 | (Yes) |
| **H3: Process level > Organizational level** | | | | | | | | | | | | | | | | |
| Process level | 35 | 11,896 | .158 | 1.595 | 10 | 1,1176 | .484 | 8.783 ** | 7 | 940 | .468 | 9.184 ** | 8 | 902 | .474 | 2.913 ** |
| Organizational level | 37 | 13,817 | .138 | (No) | 14 | 2,,417 | .213 | (Yes) | 9 | 3,714 | .170 | (Yes) | 6 | 687 | .352 | (Yes) |
| **H4: Firm level < Relational level** | | | | | | | | | | | | | | | | |
| Firm level | 35 | 16,790 | .102 | 9.986 ** | 8 | 803 | .385 | - 2.833 ** | 7 | 2,095 | .311 | - 5.051 ** | 5 | 676 | .382 | 1.666 n.s. |
| Relational level | 37 | 8,923 | .229 | (Yes) | 16 | 2,789 | .285 | (No) | 9 | 2,559 | .171 | (No) | 9 | 913 | .452 | (No) |
| **H5: Matched pair < Single informant** | | | | | | | | | | | | | | | | |
| Matched pair | 12 | 799 | .214 | - 1.216 n.s. | 2 | 90 | .391 | - .425 n.s | 4 | 684 | .464 | - 2.310 * | 2 | 151 | .364 | .905 n.s. |
| Single informant | 54 | 20,583 | .172 | (No) | 21 | 3,222 | .336 | (No) | 10 | 1,682 | .378 | (No) | 12 | 1,438 | .429 | (No) |
| **H6: Objective measurement < Perceptual measurement** | | | | | | | | | | | | | | | | |
| Objective | 14 | 5,124 | .034 | 9.102 ** | 2 | 449 | .025 | 6.648 ** | 4 | 2,692 | .059 | 14.442 ** | 1 | 123 | .003 | 5.177 ** |
| Perceptual | 58 | 20,589 | .174 | (Yes) | 22 | 3,144 | .345 | (Yes) | 12 | 1,962 | .452 | (Yes) | 13 | 1,466 | .453 | (Yes) |
| **H7: Pooled ≠ Supply chain ≠ Networked** | | | | | | | | | | | | | | | | |
| Pooled | 6 | 321 | .260 | .349 n.s, | 1 | 166 | .616 | 4.784 **, | 4 | 1,947 | .088 | 9.629 **, | 8 | 818 | .406 | |
| Supply chain | 51 | 7,229 | .241 | 2.830 **, 10.027 ** | 19 | 2,840 | .324 | 6.852 **, 4.860 ** | 8 | 1,140 | .420 | 5.584 **, 4.358 ** | 0 | 0 | n.a. | n.a. |
| Networked | 15 | 18,164 | .106 | (Partly) | 4 | 567 | .587 | (Yes) | 4 | 1,567 | .271 | (Partly) | 0 | 0 | n.a. | |
| **H8: Developing country ≠ Developed country** | | | | | | | | | | | | | | | | |
| Developing country | 6 | 516 | .453 | 8.056 ** | 4 | 637 | .378 | 2.183 * | 0 | 0 | n.a. | n.a. | 2 | 246 | .496 | 1.575 n.s. |
| Developed country | 60 | 23,479 | .129 | (Yes) | 19 | 2,862 | .294 | (Yes) | 15 | 4,560 | .234 | | 12 | 1,343 | .409 | (Yes) |

**Note:** # corr. = number of correlations; # obs. = number of observations; est. corr. = estimated correlations; indications for significance: ** p < .01, * p < .05, and n.s. p > .05; for H7 each group of Z-values displays pairwise comparisons, i.e., the first Z-value refers to pooled vs. supply chain, the second refers to supply chain vs. networked, and the third pooled vs. networked

## 1.4 Discussion

### 1.4.1 Summary of findings

Our results support the strong theoretical foundation of the relational view and its use in IS research. All four IT-based sources contribute significantly to business value. Furthermore, the capability approach founded on the resource-based view also holds true for interfirm relationships, as inter-organizational IT capabilities have a stronger relationship with business value than IT resources do. Our analysis also indicates that IT-based knowledge sharing and governance are more tightly associated with business value than IT-based inter-organizational assets and complementary capabilities are.

An explanation for this might be that – although the value of IT-based knowledge sharing and governance per se is widely known (Grover and Kohli 2012) – these sources develop their full potential when used in combination with digitally enabled interfirm business capabilities (Roberts and Grover 2012; Subramani 2004). Hence, there might be both a direct and an indirect effect of IT-based inter-organizational assets and complementary capabilities on business value. Further research is necessary to understand the interdependencies of these four IT-based sources and their co-creation mechanisms.

Regarding the value dimensions, we found evidence that inter-organizational IT first impacts the process level (H3b–d). However, we did not observe IT-based assets to have a higher value on the process level than on the organizational level. This is surprising because the support and integration of interfirm processes is an essential outcome of this IT-based source (Rai et al. 2015). Future theory development is necessary to understand the impact of IT-based inter-organizational assets on different value dimensions. However, there are reverse effects regarding IT-based knowledge sharing and complementary capabilities (H4b–c). A possible explanation for this might be that these IT-based sources have high spillover effects because firms can also use knowledge and complementary capabilities outside the relationship. Knowledge absorbed from other firms is a particularly important source for innovation and firm performance (Dyer and Singh 1998). In contrast, relation-specific assets have less value outside the relationship (Saraf et al. 2007). Future research should therefore investigate spillover effects resulting from IT-based sources of relational value more extensively.

Contrary to our expectations, we did not find any significant effects of the respondent type (H5a–d). Due to the small sample size for studies using matched pairs, these results should be interpreted with caution. Nonetheless, future studies using matched pair surveys may provide additional insight into their usefulness. Consistent with our argumentation, studies find a higher impact on business value when using perceptual measures; this finding is in line with previous research on IT value (e.g., Chau et al. 2007; Sabherwal and Jeyaraj 2015).

Regarding the type of relationship, we found mixed results. IT-based inter-organizational assets and knowledge sharing have a higher value in pooled and supply chain relationships than in networked relationships. It might be that the former relationships are characterized as more structured, making the coordination of IOS less complex than in networked relationships (Kumar and van Dissel 1996). In contrast, IT-based complementary capabilities have the lowest value in pooled interdependencies. Future research should develop theoretical foundations to understand the role of relationship types. Furthermore, we found that three IT-based sources have a stronger relationship with business value in developing countries than developed ones. Besides possible methodological issues, other explanations for this could include the presence of regulatory support, reduced competitive pressure, or the greater potential of IT capabilities in developing countries, even though companies in these countries have fewer resources to invest in IOS and develop IT capabilities (Patrakosol and Lee 2009).

### 1.4.2 Implications for research and practice

Regarding theoretical contributions, we made a first step in integrating and synthesizing the literature on IT-based value co-creation, which can be a starting point for conducting future studies. Second, our study further confirms the strong theoretical support of the relational view in IS research. Third, the results provide possible explanations for contradictory findings from previous studies. Our results reveal that across all studies inter-organizational IT significantly contributes to business value, indicating that the productivity paradox might not be an issue in IT-based value co-creation research. Fourth, our study provides insights into how future studies might be designed. Researchers should be careful when using objective measures of business value, as they might deepen the impact of inter-organizational IT. Furthermore, researchers should also be aware that the type of relationship and the economic region could influence the study's results.

This study also provides important insights into how managers can achieve superior value through IT-based value co-creation. IT executives should not focus on IT investments alone but rather develop unique inter-organizational IT capabilities to derive superior value. Furthermore, the results indicate that managers should first focus on IOS that foster knowledge sharing and governance, as these systems lead directly to value and provide a starting point for further integration with business partners. They should pay special attention to knowledge absorbed from partner firms, which can lead to superior benefits for the whole company. Lastly, IT executives should not only consider profitability-based and objective outcomes but also evaluate IOS investments based on their impacts on strategic and soft measures.

### 1.4.3 Limitations and future research

First, across all four IT-based sources of relational value, the effect sizes reveal to have a generally high degree of heterogeneity. While we were able to explain some of the variance among the studies, more analysis would be beneficial in order to both increase the methodological rigor and gain further theoretical insights. An avenue could be to assume random effects in contrast to fixed effects among the studies. Moreover, more advanced methods against a possible publication bias, e.g. using funnel plots, should be considered in further analysis. Second, due to some missing study information in our database, we decided to use a partition test and to test each hypothesis separately. More advanced meta-analysis techniques such as meta-regression in combination with data imputation techniques might be an avenue in order to account for correlations among the independent variables. Finally, to avoid a biased picture due to a "sampling bias toward empirical studies," further research should integrate our findings with other non-quantitative empirical research methods (King and He 2006).

Despite these limitations, our study provides promising directions for future research. First, interdependencies and synergies between IT-based sources of relational value should be examined. This will provide deeper insights into the success factors for IT-based value co-creation. Second, dimensions of business value should also be analyzed separately, especially regarding the spillover effects of interfirm and intrafirm value as well as the distribution of value. This will help in understanding the extent to which individual firms in interfirm relationships can benefit from IT-based value co-creation. Third, research must further develop methodological approaches to improve the reliability of research results. Besides a more frequent use of matched pair surveys, it will also be necessary to develop measures that capture the value of whole networks (Straub et al. 2004). Lastly, theoretical development is needed to understand the contextual factors that influence IT-based value co-creation.

## 1.5 Conclusion

This study set out to synthesize and explain the contradictory findings of research on IT-based value co-creation. By conducting a meta-analysis of 66 publications including over 33,000 observations, we identified valuable insights for this growing research field. To some extent, there are similar results for IT value research in general. Objective measures dampen the relationship between inter-organizational IT and business value, whereas process level measures and IT capabilities strengthen it. However, we find special IT-based co-creation mechanisms based on the relational view, indications for spillover effects, higher value impacts in developing countries, and an influence of relationship types, indicating that the interfirm context requires special attention in IT value research. Our study provides contributions to both theory and practice and can guide future research and theory development.

## 1.6 Appendix

*Table B-5. List of studies used for the meta-analysis*

| | Sample size | IT-based inter-org. assets | IT-based knowledge sharing | IT-based compl. capabilities | IT-based governance |
|---|---|---|---|---|---|
| (Al-Duwailah et al. 2015) | 307 | .420, .620 | | | |
| (Bardhan et al. 2006) | 287 | .013 | | | |
| | 266 | .200 | | | |
| (Bardhan et al. 2007) | 708 | -.043, .099 | | | |
| (Barua et al. 2004) | 1.076 | .528 | .095, .238 | | |
| (Bharadwaj et al. 2007) | 126 | .090 | .090 | | .003 |
| (Chen et al. 2009) | 491 | | | | .550 |
| (Chen et al. 2013) | 117 | .361 | | | |
| (Cheng et al. 2014) | 260 | | | .590 | |
| (Choi and Ko 2012) | 119 | | .460 | | .550 |
| (Devaraj et al. 2007) | 120 | .001 | | | |
| (Dobrzykowski 2012) | 711 | .189, .043 | | | |
| (Dröge and Germain 2000) | 200 | .018, .152 | | | |
| (Gang et al. 2008) | 284 | | .411 | | |
| (Hadaya and Cassivi 2012) | 51 | .526, .123 | | | |
| (Hyvönen 2007) | 51 | .356 | | | |
| (Im and Rai 2014) | 238 | .365 | | | .395 |
| | 76 | .160 | | | .255 |
| (Jean et al. 2010) | 240 | .321, .325 | | | |
| (Jeong et al. 2009) | 121 | | | .530 | |
| (Jiang and Zhao 2014) | 128 | .300, .582 | | | |
| (Kaefer and Bendoly 2004) | 186 | | | .081, .165 | |
| (Klein and Rai 2009) | 91 | .120 | | | |
| | 132 | .210 | | | |
| (Ko et al. 2009) | 169 | | .616 | .578 | .515 |

*Continued on Page 52*

*Continued from Page 51*

| | | | | | |
|---|---|---|---|---|---|
| (Kyu Kim et al. 2011) | 51 | | .252 | | |
| | 51 | | .514 | | |
| (Lai et al. 2008) | 227 | .625, .621 | .639, .604 | | |
| (Lee and Wang 2013) | 147 | .340 | | .257 | |
| (Lee et al. 2014) | 124 | | .350 | | |
| (Liu et al. 2013) | 252 | | .380, .490 | | .460, .530 |
| (Liu and Ravichandran 2011) | 329 | | .000 | | |
| (Loukis and Charalabidis 2012) | 14,065 | .122, .099, .176, .082, .076, .088 | | | |
| (Lu and Wang 2012) | 121 | .177 | | | |
| (Nicolaou et al. 2011) | 116 | .170 | | | .260 |
| (Patrakosol and Lee 2009) | 68 | .400 | | | |
| | 107 | .350 | | | |
| (Paulraj et al. 2008) | 212 | .200, .210 | | | |
| (Prasad et al. 2013) | 192 | | | | .361 |
| (Rai et al. 2006) | 110 | .230, .130, .140 | .290, .170, .150 | | |
| (Rai et al. 2012) | 1,659 | | | .023 | |
| (Rai et al. 2015) | 342 | .082 | | | |
| (Rai and Tang 2010) | 318 | .338 | | .383 | |
| (Rajaguru and Matanda 2013) | 302 | | | .506 | .626 |
| (Ramamurthy et al. 1999) | 83 | .250 | | | |
| (Roberts and Grover 2012) | 108 | .140 | | .290 | |
| (Rosenzweig 2009) | 170 | | | | .470, .480 |
| (Ryoo and Kim 2015) | 70 | .420, .280 | | | |
| (Saeed et al. 2005) | 38 | -.080, .380 | | | |
| (Saldanha et al. 2013) | 3.023 | -.011 | | | |
| (Sanders 2007) | 245 | .296 | | | |
| (Saraf et al. 2007) | 63 | .251 | | | |
| (da Silveira and Cagliano 2006) | 201 | .154 | | | |
| (Sriram and Stump 2004) | 318 | -.143 | | | |
| (Subramani 2004) | 131 | .086, .219 | | .005, .348 | |
| (Tafti et al. 2013) | 635 | | | .103 | |
| (Tallon and Pinsonneault 2011) | 241 | .090 | | | |
| (Tanriverdi 2006) | 356 | | | .113 | |
| (Truman 2000) | 48 | .066 | | | |
| (Vaccaro et al. 2010) | 113 | | .142 | | |
| (Vickery et al. 2003) | 57 | .052, .200 | | | |
| (Wang et al. 2013) | 144 | | | | .300 |
| (Wang et al. 2015) | 150 | .460 | .510 | | |
| (Wong et al. 2012) | 188 | | .450, .500 | | |
| (Wong et al. 2015) | 188 | .520 | .469 | | .557 |
| (Xu et al. 2014) | 176 | .340 | | | |
| (Xue et al. 2013) | 421 | .146, .118 | | | |
| (Yao et al. 2009) | 215 | | .270 | | |
| (Zhao and Xia 2014) | 194 | .290, .335 | .253 | .290 | |
| (Zhu et al. 2004) | 612 | .480 | | | |
| (Zhu et al. 2015) | 196 | .600, .501 | | | |

# 2 Study #2: IT and Organizational Agility – A Meta-Analysis

*Table B-6. Fact sheet of Study #2*

| | |
|---|---|
| Title | Diving into the Relationship of Information Technology and Organizational Agility: A Meta-Analysis |
| Authors | Daniel Leonhardt, dleonha@uni-goettingen.de[*]<br>Markus Mandrella, mmandre@uni-goettingen.de[**]<br>Lutz M. Kolbe, lkolbe@uni-goettingen.de[**]<br><br>[*]Georg-August-Universität Göttingen, Chair of Information Management, Humboldtallee 3, 37073 Göttingen<br>[**]Georg-August-Universität Göttingen, Chair of Information Management, Platz der Göttinger Sieben 5, 37073 Göttingen |
| Outlet | Proceedings of the International Conference on Information Systems (ICIS) 2016, Completed Research Paper |
| Abstract | Organizational agility is perceived as a key capability for a quick adaptation to environmental changes caused by ongoing digitization. A large stream of IS research has dealt with the relationship of IT and organizational agility, but lacks a synthesis regarding construct definitions and conflicting arguments. Therefore, we conducted a meta-analysis including 41 empirical studies that analyzed an IT – organizational agility relationship. First of all, the analysis identified a positive relation between all dimensions of IT and organizational agility. Drawing on the resource based view of the firm, we found that IT capabilities have a stronger influence on agility outcomes than IT resources. Moreover, we collected evidence revealing a higher impact from dynamic capabilities compared to operational IT variables. This study contributes to theory by synthesizing research on IT-enabled organizational agility. By doing so, the relationship between IT and organizational agility is clarified, and possibilities for further research are derived. |
| Keywords | Information technology; Organizational agility; Meta analysis |

## 2.1 Introduction

The ongoing digitization of the business environment of today requires firms to constantly adapt to changing circumstances (Del Giudice and Straub 2011; Khan and Sikes 2014; Yoo et al. 2012). As information technology (IT) is ubiquitously integrated in products and services, it both enables and triggers innovation (Lusch and Nambisan 2015; Nambisan 2013). Technological advancements force organizations to constantly innovate to stay competitive (Del Giudice and Straub 2011). Due to the disruptive nature of digitization, companies that rest on their laurels may be pushed out of their core business (Fitzgerald et al. 2013; Loebbecke and Picot 2015). Thus, a quick adaptation to changes is essential for the success. Organizational agility is perceived as a key capability for this demand (e.g., Chakravarty et al. 2013; Lu and Ramamurthy 2011; Overby et al. 2006; Sambamurthy et al. 2003; Tallon and Pinsonneault 2011). To successfully manage digital transformations, it is crucial to sense and respond to new opportunities, often enabled by information technology (Nazir and Pinsonneault 2012; Overby et al. 2006). Organizational agility is also often associated with performance outcomes, underlining its importance (Bazigos et al. 2015; Chen et al. 2014; Tallon and Pinsonneault 2011). Digitization also fosters environmental turbulence, which increases the positive effect of agility on firm performance (Tallon and Pinsonneault 2011).

The relationship of IT and organizational agility was examined by a number of authors, but the research seems scattered in several aspects: First, the impact of IT on organizational agility is a controversial issue (Lu and Ramamurthy 2011). The majority of studies argue or find empirical evidence for a positive influence of IT on organizational agility (e.g., Lu and Ramamurthy 2011; Rai and Tang 2010; Roberts and Grover 2012), because IT should enable and facilitate flexible processes and innovation by building digital options (Chen et al. 2014; Sambamurthy et al. 2003; Tallon 2008). However, there are also arguments that IT impedes organizational agility, since information systems may introduce rigidity and inflexibility (Overby et al. 2006; van Oosterhout et al. 2006). Second, the concepts of IT largely differ from study to study. While some researchers examine IT capabilities (e.g., Lee et al. 2015), others include IT resources (e.g., Lu and Ramamurthy 2011). Third, the construct and definition of organizational agility is not consistent. It can be seen from a more strategic point of view on a firm level (e.g., Kharabe et al. 2013), but also from an operational viewpoint on a process level (e.g., Lee et al. 2009). Other definitions contain elements like market capitalizing and operational adjustment agility (Lu and Ramamurthy 2011), sensing and responding (Overby et al. 2006), or entrepreneurial and adaptive organizational agility (Chakravarty et al.

2013). Fourth, attributes of the study, such as the underlying methodology, might influence the results. Therefore, it would be beneficial to resolve that contradiction by a summary of existing research on the relationship. Moreover, since organizational agility is ever more important during the digitization of products, services, and business processes, we seek to enhance the understanding of the relationship between IT and organizational agility, while contributing towards future research and theory development.

We therefore aim to synthesize and explain contradictory findings of research on IT-enabled agility. To do so, we aim to answer the following research questions: (1) Which IT factors enhance organizational agility with regards to magnitude? (2) To which dimensions of organizational agility does IT lead? (3) How do the attributes of the studies affect the relationship between IT and organizational agility?

To answer these research questions, we conducted a meta-analysis including 41 quantitative studies with a total sample size of 7,646. By doing so, we aim to synthesize prior empirical results while identifying moderators of the relationship between IT and organizational agility. Building on the resource-based view (RBV) and the dynamic capability framework, as well as synthesizing findings from previous research, we hypothesized that IT enables organizational agility. To analyze this relationship more deeply, we further distinguish between entrepreneurial and adaptive agility. Moreover, we coded for several moderating variables and hypothesized how they influenced the results: (1) IT resources vs. IT capabilities, (2) operational IT capabilities vs. dynamic IT capabilities, and (3) process-level vs. organizational level of agility. Furthermore, we investigated whether variation across studies is a result of the attributes of the studies.

The paper continues with providing the theoretical foundations for organizational agility and the impact of IT. We then propose a research model and develop hypotheses concerning IT-enabled organizational agility by summarizing existing research findings and drawing on the theoretical foundations. Applying a meta-analysis including a partition test, the hypotheses are tested. Afterwards, the results are discussed and implications for theory and practice are presented. Finally, the limitations of this study and further research possibilities are described. The study closes with a conclusion.

## 2.2 Theoretical Foundations

### 2.2.1 The concept of organizational agility

Organizational agility is defined as a firm's ability to sense and respond effectively to opportunities and threats arising from changing environments (Overby et al. 2006; Roberts and Grover 2012; Sambamurthy et al. 2003). It extends the concept of flexibility by encompassing both a strategic and operational level, while additionally requiring a response that is more difficult to predict and predetermine (van Oosterhout et al. 2006). It commonly consists of two components: (1) sensing environmental change and (2) responding readily (Overby et al. 2006). A firm's ability to perform different actions to seize and respond to environmental changes by leveraging IT (Sambamurthy et al. 2007), requires us to break down the concept of organizational agility into more detail. By doing so, we aim to examine different mechanisms and concepts of IT-enabled agility across the identified studies. Specifically, we build on the distinction between entrepreneurial and adaptive agility by Bharadwaj and Sambamurthy (2005). Entrepreneurial agility refers to a proactive way in sensing and responding to environmental changes by creating radically new business approaches, processes, products, or services. The aim is to realize first-mover advantages. In contrast, adaptive agility is characterized as a reactive type of agility, focusing on actions, such as adjusting prices or refining business processes, to keep pace with upcoming industry innovations. The desired strategic goal is to maintain the competitive position while being resilient to environmental change. The distinction between entrepreneurial and adaptive agility is also consistent with similar concepts in IS and strategy management literature: exploration and exploitation (Sambamurthy et al. 2003), proactiveness and reactiveness, preemptiveness and resilience, radical and incremental innovation (Sambamurthy et al. 2007), as well as offensive and defensive modes of strategy execution (Miles and Snow 1978). Furthermore, this conceptualization has been widely used in research regarding IT-enabled organizational agility (e.g., Chakravarty et al. 2013; Kharabe et al. 2013; Sambamurthy et al. 2007) and thus provides a robust theoretical foundation for further analysis.

### 2.2.2 The capability-development process for organizational agility

As a theoretical basis for the relationship between IT and organizational agility, we build on the capability-development process, which is rooted in the IS and strategic management literature (Lee et al. 2015). Based on the RBV, it is argued that firms achieve competitive advantage by developing IT capabilities, i.e., the mobilization and deployment of IT resources in combination with complementary organizational capabilities and resources (Bharadwaj 2000). Organizational capabilities are widely classified as a hierarchy, with a set of lower-order capabilities being leveraged to develop higher-order capabilities, which in turn lead to superior performance gains (Barua et al. 2004; Rai et al. 2006; Sambamurthy et al. 2003). The dynamic capability theory extends the RBV and defines dynamic capabilities as "*the firm's ability to integrate, build, and reconfigure both internal and external competences to address rapidly changing environments*" (Teece et al. 1997, p. 516). Hence, firms need to continously adapt and renew their resources and capabilities to respond to environmental change, thus to sustain a competetive advantage over time. Organizational agility is typically conceptualized as a higher-order dynamic capability, and therefore as an immediate antecedent of business performance (Lee et al. 2015; Sambamurthy et al. 2003). IT capabilities are widely characterized as lower-order capabilities which shape the development of higher-order capabilities, thus being an enabler for organizational agility (Chakravarty et al. 2013; Lu and Ramamurthy 2011).

## 2.3 Research on IT-Enabled Organizational Agility

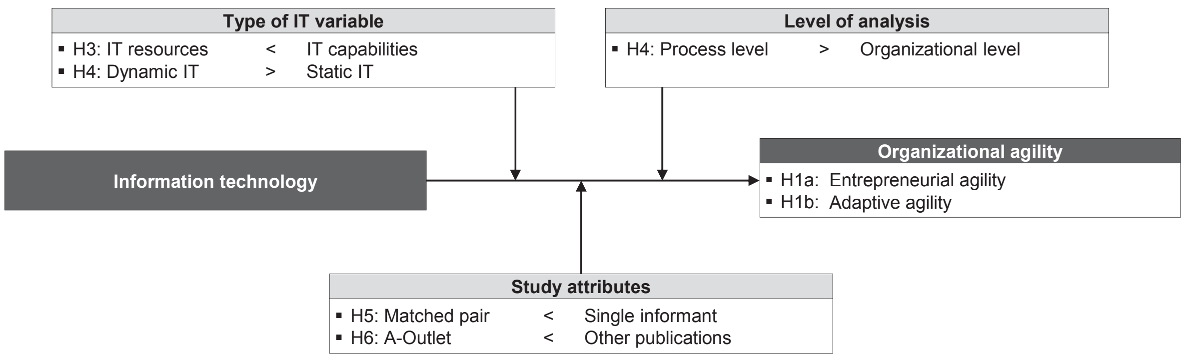


*Figure B-2. Proposed research model*

In the following, we develop hypotheses regarding the impact of IT on both entrepreneurial and adaptive agility. In this study, we adopt a broad view of the term IT (Kohli and Grover 2008). Beside IT-related resources like hardware and software, we especially include IT management and organizational concepts, such as IT competencies or managerial capabilities. The reason is that IT-enabled agility is, as mentioned above, created through a capability-development process. Furthermore, we identify structural dimensions of the studies and hypothesize how they moderate this relationship. Building on the RBV and the dynamic capability framework, we first hypothesize the impact of different types of IT variables on organizational agility. We then analyze the influence on different levels of analysis regarding organizational agility. Finally, the moderating role of the attributes of the studies are examined. The research model is summarized in Figure B-2.

### 2.3.1 The impact of IT on organizational agility

Although IT is widely recognized as an enabler for organizational agility, IT may also be a disabler in this context: First, IT-induced integration and process automation might lead to rigid processes and barriers to change (Overby et al. 2006). This is especially the case when firms highly depend on monolithic and legacy IT infrastructures, which limit the range of actions, making change complex and cost-intensive (Kharabe and Lyytinen 2012). Second, the duality of technology implies that IT can both enable and disable change, for example, if users resist newly introduced IS (Lu and Ramamurthy 2011). Third, highly customized IT might be incompatible with third parties, such as suppliers and customers, reducing the flexibility of collaboration activities (Overby et al. 2006). Fourth, companies bear the risk that managers rely on well-established IT capabilities and best practices, not being open-minded about fundamental changes (Kharabe and Lyytinen 2012). However, we argue that the enabling role of IT outperforms these negative aspects, which are mostly a result of inappropriate IT investments (Overby et al. 2006). Following the logic of the capability-development process, IT resources and capabilities can be leveraged in combination with other organizational resources and capabilities, developing a higher-order capability of organizational agility (Sambamurthy et al. 2003). Therefore, IT has an enabling role for organizational agility in the following ways: First, advanced information processing in terms of storage, sharing, analysis, and transformation of data foster and improve information flow and knowledge sharing, both in and between firms, which is crucial for achieving agility (Chen et al. 2014; Sambamurthy et al. 2007). Second, IT can speed up communication in order to anticipate and respond faster to change (Chakravarty et al. 2013; Overby et al. 2006). Third, through standardized processes, structured transaction data, and automation; IT improves the coordination of internal and external business processes and activities (Gosain et al. 2004; Roberts and Grover 2012). In the following, we shed light on the specific enabling mechanisms of IT regarding entrepreneurial and adaptive agility.

The concept of entrepreneurial agility has found less attention in IS research than adaptive agility. However, existing studies (e.g., Chakravarty et al. 2013; Kharabe et al. 2013) indicate that IT positively impacts this type of agility by facilitating both sensing and responding abilities. Data warehouses, data monitoring, or pattern recognition lead to a higher quality, availability, and flow of information, enabling to sense new opportunities and threats (Overby et al.

2006). For example, web-based information systems enhance the development of customer-based innovations (Roberts and Grover 2012). Moreover, well-advanced IT managerial skills and capabilities improve strategic foresight and learning abilities to identify new opportunities (Chakravarty et al. 2013). Regarding responding abilities, an appropriate IT infrastructure broadens a firm's possibilities of competitive actions (Fink and Neumann 2007). For instance, exploitation of emerging IT opportunities facilitates the development of new business models, penetration of new markets, and establishment of new types of interfirm collaboration (Sambamurthy et al. 2007). Furthermore, a mature IT infrastructure is accompanied by the modularization and atomization of business processes which can be recombined to develop innovative business processes (Sambamurthy et al. 2003). Lastly, improved knowledge sharing through IT facilitates the spreading of novel ideas within and across firms (Mao et al. 2013; Overby et al. 2006). Therefore, we propose a first hypothesis:

**H1a:** Information technology is positively related to entrepreneurial agility.

IS research has widely investigated the impact of IT on various types of adaptive agility, such as supply chain agility (Liu et al. 2013), business process agility (Tallon 2008), and value chain agility (Swafford et al. 2006). We also argue that IT enhances both sensing and responding abilities of adaptive agility. Regarding sensing abilities, increased visibility of data and reduced information asymmetries within and between firms help to anticipate changes and recognize patterns (Chakravarty et al. 2013). Moreover, IT can enrich knowledge about operational deficiencies in business processes (Overby et al. 2006) and lead to faster, more informed decision making (Mao et al. 2013; Sambamurthy et al. 2003). IT also enhances responding abilities by improving coordination for the adjustment of internal and interfirm business processes (Chen et al. 2014; Tallon 2008). For instance, advanced IT infrastructure capabilities, which can quickly provide and introduce new IT services, help companies to quickly adapt to changing environments (Sambamurthy et al. 2007). Moreover, IT shortens the response time to changing market conditions by improving communication within and between firms (Chen et al. 2014). Lastly, increased information integration reduces the need for physical coupling, thus enhancing flexibility (Roberts and Grover 2012). Therefore, we propose a second hypothesis:

**H1b:** Information technology is positively related to adaptive agility.

### 2.3.2 Type of IT variable

Having hypothesized that IT impacts both entrepreneurial and adaptive agility, we now examine which types of IT were investigated in the literature, and how this could affect the relationship between IT and organizational agility. We thereby draw on the capability-development process, which is theoretically grounded in the RBV and the dynamic capability framework.

Based on these theoretical insights, we first distinguish between IT resources and IT capabilities in achieving organizational agility. In research on IT-enabled agility, IT resources are assessed by investments in IT (e.g., Lu and Ramamurthy 2011), the adoption of specific systems, such as inter-organizational systems (e.g., da Silveira and Cagliano 2006), or the availability of a general IT infrastructure (e.g., Lee et al. 2013). IT resources are crucial for enabling organizational agility as they provide the technical infrastructure to process a high volume of information, as well as to automate and coordinate responses to environmental changes, thus making complex agility actions possible (Overby et al. 2006). However, we argue that IT capabilities have even a greater impact on organizational agility. Following the logic of the RBV, IT resources are mobilized and deployed to develop IT capabilities, distancing them from higher-order dynamic capabilities and resulting performances. The value of IT thus results from its complementarities with other organizational resources and capabilities (Bharadwaj 2000; Wade and Hulland 2004), which also holds true for achieving agility. As a capability, IT serves as a platform for enabling a business infrastructure that shapes digital options and agility (Sambamurthy et al. 2003), while becoming more customized to the specific challenges that arise in changing business environments (Kharabe and Lyytinen 2012). Moreover, high imprudent investments in IT resources might lead to rigid IT infrastructures, hindering the adaptation and launch of innovative business activities (Lu and Ramamurthy 2011). In contrast, organizations with advanced IT capabilities are characterized by making more balanced and focused investments in IT, increasing their flexibility regarding new IT investments necessary to respond to environmental challenges. We therefore propose the following hypothesis:

**H2:** IT capabilities have a greater impact on agility than IT resources do.

We further distinguish between operational and dynamic IT capabilities. Based on the definition of dynamic capabilities, the latter one refers to the ability of a firm to continuously develop and reconfigure its IT resources to respond to environmental changes (Fink and Neumann 2007; Tiwana and Konsynski 2010). In research on IT-enabled agility, it encompasses for example the flexibility (Liu et al. 2013) and reconfiguration ability (Rai and Tang 2010) of an IT infrastructure. In contrast, operational IT capabilities, for example IS integration (Roberts and Grover 2012), refer to business as usual routines and processes, not being concerned with change (Daniel et al. 2014; Teece et al. 1997). We argue that dynamic IT capabilities have a greater influence on organizational agility than operational IT capabilities. In order to respond to environmental changes, firms need to continuously reconfigure and renew information systems due to changing business requirements (Fink and Neumann 2007). By building such dynamic IT capabilities, fast changes in information systems also support faster adaptations of business processes and launching of innovations (Kharabe and Lyytinen 2012). For instance, highly modularized IT infrastructures ease changes by lowering independencies and therefore preventing perturbances ("encapsulation") between applications as well as facilitating the introduction of new systems based on innovative technologies by being compatible with established IT standards in the organization (Tiwana and Konsynski 2010). In contrast, reliance on rigid legacy systems would hinder to respond quickly to changing environments (Chen et al. 2014). Moreover, firms having installed dynamic IT capabilities can quickly provide IT services to better respond to changing information needs (Fink and Neumann 2007). Therefore, we propose the following:

**H3:** Dynamic IT capabilities have a greater impact on organizational agility than operational IT capabilities and IT resources do.

### 2.3.3 Level of analysis

Organizational agility can be assessed at different levels of analysis (Mathiassen and Pries-Heje 2006). First, agility can be analyzed at the firm-level. Second, researchers investigate the agility of specific business processes, such as supply chain processes (Liu et al. 2013) or manufacturing processes (Ojha et al. 2015). Business process agility thus refers to a firm's agility to refine (adaptive agility) or create new (entrepreneurial agility) business processes in order to respond to environmental changes (Chen et al. 2014; Tallon 2008). IS researchers widely agree that IT first impacts business process measures, which ultimately lead to overall organizational outcomes (e.g., Brynjolfsson and Hitt 2000; Dehning and Richardson 2002; Melville et al. 2004). We argue that this also applies to agility, especially because responding capabilities primarily depend on the coordination and integration of a firm's internal and external business processes (Roberts and Grover 2012). These business processes in turn heavily rely on a firm's ability to mobilize IT resources due to the impact of IT on the swiftness, adaptability, and robustness of business processes (Chen et al. 2014; Weill et al. 2002). However, firm-level agility depends more heavily on numerous other factors, such as research and development capabilities along with market intelligence (Overby et al. 2006), possibly dampening the impact of IT on agility. Therefore, we propose the following hypothesis:

**H4:** Information technology has a greater impact on process-level agility than on firm-level agility.

### 2.3.4 Study attributes

Various methodological and contextual attributes have been shown to influence the results of studies in quantitative IS research (e.g., Gerow et al. 2014; Sabherwal and Jeyaraj 2015). We first analyze the type of respondents: data can be gathered from a single informant or by matching responses from two individuals in the same firm. In the case of a matched pair strategy, data regarding the IT constructs is typically gathered from IS executives, whereas business executives respond to organizational and agility-related questionnaire items (e.g., Chen et al. 2014; Lee et al. 2015; Lu and Ramamurthy 2011). In comparison, matched pair surveys tend to be more reliable because single informants may not have adequate expertise of both IS and business practices within the firm (John and Reve 1982; Kyu Kim et al. 2011). Moreover, the use of single informants leads to increased common method bias (Podsakoff et al. 2003). However, a matched pair study compromises the anonymity of the survey (Kearns and Sabherwal 2007) and can cause measurement errors due to subjectivity (Tallon 2007). Due to the bias resulting from single respondents and based on results in other IS topics (e.g., Gerow et al. 2014), we hypothesize that using single respondent types will result in larger estimates of organizational agility:

**H5:** Information technology has a greater impact on organizational agility in studies that use single respondent types.

We furthermore include the publication type as an additional moderator. The validity of literature review and meta-analytical research might be threatened by publication bias or the "file drawer problem" (Rosenthal 1979). It is widely accepted that highly refereed journals and outlets are more likely to accept studies that report significant results than unpublished and less refereed conferences (Hunter and Schmidt 2004; King and He 2005; Sharma et al. 2009). We also expect that highly-ranked outlets will report larger effect sizes in our sample than other publications, and therefore propose the following hypothesis:

**H6:** Information technology has a greater impact on organizational agility in studies that are published in A-ranked outlets than in other publications.

## 2.4 Meta-Analysis

This study uses a meta-analysis, including a partition test, to analyze the relationship of IT and organizational agility. The basic purpose of a meta-analysis is to integrate empirical studies quantitatively to verify the results using a larger data base (Glass 1976; Hedges 1992). Moreover, it can be used to examine the variability of the considered relationship and to test for moderators (Field 2001; Johnson et al. 1995). This approach is particularly suitable for our research question, since it enables us to quantitatively integrate existing results and to test for moderators using a large empirical data base. In the following, the process of the meta-analysis is described, including the data collection, coding, and analysis.

### 2.4.1 Data collection procedure

The empirical studies that are included in the meta-analysis should be collected in a systematic and reproducible way (King and He 2005). First, we used a keyword search in various electronic databases to find relevant empirical studies (Hunter and Schmidt 2014). We scanned the AIS electronic Library (AISeL), ScienceDirect (ELSEVIER) and the Business Source Complete (EBSCOhost) database using the following search term: ("information system*" OR „information technology") and ("agility" OR "flexibility"). Conference proceedings were explicitly included to avoid a bias toward higher effects sizes in journal articles called "file drawer problem" (Rosenthal 1979). We also used citations in the identified publications and Google scholar to find additional articles to complement our data base.

To ensure the relevance of the identified studies, we used four inclusion criteria (Wu and Lederer 2009). First, the study had to include some sort of IT capability or resource in their model in line with our conceptualization of IT described in the research model. Second, a construct relating to organizational agility should be included in the research model. We also included studies that examined similar concepts such as flexibility. For instance, Saini and Johnson (2005) use the construct strategic flexibility, which they define as "*[…] a capability that enables a firm to respond to and generate environmental change*". In comparison, organizational agility is defined as a firm's ability to sense and respond effectively to opportunities and threats arising from changing environments (Overby et al. 2006; Roberts and Grover 2012; Sambamurthy et al. 2003). Due to the similarity in the definition and the relatedness of these constructs (van Oosterhout et al. 2006), we included all studies with agility or flexibility constructs that reflect the idea of responding to changes in the business environment. Third, the study had to report sample sizes and reliabilities of measures of the variable. Fourth, the study had to report sufficient data to derive a correlation value for the relationship of IT and organizational agility. In the case that studies included several IT or organizational agility variables, the correlations were derived according to the subsequent coding procedure. If the differences between the variables were important for the hypotheses, they were coded as different relationships. If not, they were arithmetically averaged (Hunter and Schmidt 2014). As it is important for the results of the meta-analysis to only include unique and independent studies, we compared author information as well as descriptive and statistical data (Wu and Lederer 2009). For data sets that were reported more than one time (e.g., conference proceedings and journal article), we selected only one for our data set.

The final sample contains 41 publications that empirically tested a model comprising IT and organizational agility. The publication year ranges from 2001 to 2015. In total, the data set comprises a sample size of 7,646, which consists of the individual sample sizes of the 41 individual studies. All studies used primary data for their analyses. Table B-7 below presents an overview of the different journals and conferences that are included in our data set. A full list of the individual publications including additional information can be found in the Appendix.

*Table B-7. Study distribution*

| Rank | Journal/Conference | Number of articles |
|---|---|---|
| 1 | Pacific Asia Conference on Information Systems (PACIS) | 6 |
| 2 | Information Systems Research | 5 |
| 3 | International Conference on Information Systems (ICIS) | 4 |
| 4 | MIS Quarterly | 3 |
| 4 | European Conference on Information Systems (ECIS) | 3 |
| - | Other Journal Publications | 18 |
| - | Other Conference Publications | 2 |

### 2.4.2 Coding of studies

The coding of the identified studies encompassed basic information, such as author, year or title, the correlation value between IT and organizational agility constructs and the coding of the moderators. For studies that did not report correlation values directly, we used the methods described in Wu and Lederer (2009) to calculate a correlation (e.g., calculating the squared root of the shared variance $r^2$).

To be able to test the hypotheses H1a and H1b, we coded for entrepreneurial and adaptive organizational agility by applying the definition of Chakravarty et al. (2013). Moreover, we differentiated between IT resources and IT capabilities, which can be dynamic or static, relating to hypothesis H2 and H3. For the organizational agility construct, we further distinguished between process-level and firm-level agility (H4). Methodologically, we coded for "matched pair / single informant" to assess hypothesis H5. For the publication quality, we differentiated between A+/A ranked publications (according to the VHB-JOURQUAL3 ranking[4]) and the remaining journals and conference proceedings (H6). The coding procedure follows the definitions that are established in the development of the hypotheses.

### 2.4.3 Data-analysis and results

Our analysis follows the guidelines of Hedges and Olkin (1985) for fixed effects meta-analyses. After applying Fisher's z-transformation to convert the correlation values into a standard normal metric, we used the inverse sampling error variance as weights for the individual studies (Shadish and Haddock 1994; Wilson and Lipsey 2000). This procedure takes the different sample sizes of the individual studies into account (Wilson and Lipsey 2000). Prior to the meta-analysis, we performed a homogeneity test to statistically evaluate the variability of the effect sizes in the data set. A significant chi square test result provides an indicator for heterogeneity of the effect sizes and indicates the existence of moderating factors (Hedges and Olkin 1985; King and He 2005). The test determined a Q-value of 249.47, which is highly significant ($p < .001$), thus indicating potential moderators.

The results of the meta-analysis relating to hypothesis H1a and H1b are presented in Table B-8 below. Both hypotheses can be confirmed. They feature positive mean correlation values, and the according confidence and credibility intervals do not include zero, supporting the positive relationship of IT and organizational agility (Hunter and Schmidt 2014). The credibility interval is a measure for the distribution of the effect sizes, and a wide interval or an interval that includes zero indicates the existence of moderators. The large interval for adaptive agility (> .40) supports the assumptions regarding moderators. It is notable that a relatively low number of five individual studies analyzed a relationship including IT and entrepreneurial agility. The relationship seems to be similar to adaptive agility, but the results should be evaluated carefully due to the low number of studies. A partition test revealed a non-significant difference between the two groups ($p > .10$). In order to examine our results for robustness, we calculated fail-safe N values. These values estimate the amount of studies with null results that are needed to diminish the average correlation to a certain value, which we set to .05 (Williams and Livingstone 1994). Compared to the number of correlations, our fail-safe N values are larger, indicating that unpublished studies are not a threat.

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[4] Available at http://vhbonline.org/en/service/jourqual/vhb-jourqual-3/complete-list-of-the-journals/

*Table B-8. Meta-analysis results*

| Hypothesis | # corr. | n | Mean corr. | Std. error | Confidence interval (.95) | Credibility interval (.80) | $SD_r$ | Fail-safe N |
|---|---|---|---|---|---|---|---|---|
| H1a: entrepreneurial agility | 5 | 870 | .336 | .034 | .270 - .403 | .256 - .416 | .062 | 28 |
| H1b: adaptive agility | 40 | 7,466 | .384 | .012 | .362 - .407 | .162 - .606 | .173 | 267 |

*Note: # corr. = number of correlations; n = number of observations; Mean corr. = weighted average correlation estimate; Std. error = Standard error of Mean corr.; $SD_r$ = Standard deviation of correlations; Fail-safe N = #studies * (Mean corr. - .05) / .05*

For the following moderator test, we did not further differentiate between entrepreneurial and adaptive agility, because of the low amount of studies considering entrepreneurial agility and the small difference between the mean correlations of both groups. We applied a partition test to check our hypotheses relating to moderating effects (King and He 2005). Therefore, the studies were grouped according to the moderating variable and two separate meta-analyses were computed. Afterwards, the average weighted z-values of both groups could be compared using a z-test (Hedges and Olkin 1985). By this means, the hypotheses relating to the different moderators of the relationship of IT and organizational agility could be tested in a quantitative manner. The results of this procedure are presented in Table B-9.

*Table B-9. Partition test results*

| Hypothesis | # corr. | n | Mean corr. | z-value (Hypothesis supported) |
|---|---|---|---|---|
| **H2: IT resources < IT capabilities** | | | | |
| IT resources | 11 | 2,663 | .257 | -7.726** |
| IT capabilities | 35 | 6,472 | .414 | **(Yes)** |
| **H3: Dynamic > Static** | | | | |
| Dynamic | 21 | 4,210 | .464 | 7.832** |
| Static | 27 | 5,186 | .327 | **(Yes)** |
| **H4: Process-level > Firm-level** | | | | |
| Process-level | 20 | 3,522 | .384 | 0.153 |
| Firm-level | 21 | 4,094 | .381 | **(No)** |
| **H5: Matched-Pair < Single Informant** | | | | |
| Matched-Pair | 7 | 1,329 | .402 | 0.896 |
| Single Informant | 34 | 6,317 | .379 | **(No)** |
| **H6: A-Outlet > Other Publications** | | | | |
| A-Outlet | 18 | 3,600 | .336 | -3.874 |
| Other Publications | 23 | 4,046 | .424 | **(No)** |

*Note: # corr. = number of correlations; n = number of observations; Mean corr. = weighted average correlation estimate; indications for significance: ** $p < .01$; z-values are the result of pairwise comparisons of the two groups*

The partition test shows that our data supports H2 and H3, but finds no significant differences for H4 and H5. The correlation between IT resources and organizational agility is significantly lower than for IT capabilities (H2). Moreover, IT variables that were coded as dynamic featured a significantly higher correlation with organizational agility than static variables, thus supporting H3. For process-level and firm-level agility, we find nearly equal values for the weighted average correlation, which does not support H4. A lower number of 7 studies used matched pairs for gathering empirical data, compared to 34 studies that relied on single informants. In this case, we also did not find a significant difference in the weighted average correlation between both groups (H5). A relatively large group of 18 studies originates from high ranked publications, but the weighted average correlation estimate is actually significantly higher in the lower ranked publications. Thus, hypothesis H6 is also not supported.

## 2.5 Discussion

### 2.5.1 Summary of findings

By integrating existing empirical results of studies investigating IT-enabled agility, we aimed to verify the positive relationship between IT and agility. The synthesis of 41 empirical studies provides evidence that the IT—organizational agility relationship is indeed positive across studies (H1a-b), thus resolving prior contradictory arguments. These results suggest that information systems do not introduce rigidity and inflexibility, as argued in some other studies (Overby et al. 2006; e.g., van Oosterhout et al. 2006). Large, complex legacy systems may still have negative effects on the organizational agility, but the aggregate effect is not, according to our data, negative. Therefore, our study shows the importance of IT in an agile organization that is able to sense and respond to relevant changes. As digital business models require a quick adaptation to technological trends, the future role of the IT department may shift from a "cost and efficiency focus" to innovation. These contradictory demands lead to concepts like IT ambidexterity (e.g., Gregory et al. 2015) or a bimodal IT organization (e.g., Avedillo et al. 2015). We further distinguished between entrepreneurial and adaptive agility, which enables a differentiation between proactive and reactive ways of dealing with environmental changes (Bharadwaj and Sambamurthy 2005). Although our results must be interpreted with caution due to the low number of correlations regarding entrepreneurial agility, we provide initial evidence that IT enhances both types of agility by the same magnitude. However, this result has to be verified by further research. In the business environment of today, digitization changes the role of IT, which is increasingly bound to innovation and can serve strategic differentiation (Bharadwaj et al. 2013; Yoo et al. 2012). Thus, the reactive approach of responding to changes alone might be insufficient for achieving organizational agility.

We further aimed to investigate how different types of IT variables influence the impact on organizational agility, which might also explain some of the contradictory evidence and arguments in this research stream. Our results provide strong theoretical support of the RBV and the dynamic capability theory in order to explain how IT enables organizational agility. First, our findings show that both IT resources and IT capabilities have a positive influence on organizational agility in general. However, this positive impact is significantly higher for IT capabilities compared to IT resources (H2), providing evidence that the capability approach founded on the RBV also holds true for achieving agility. Moreover, these results also support findings exemplified from Lu and Ramamurthy (2011), who found a negative impact of IT spending on agility, but a positive effect of IT capabilities. Therefore, IT investments should be properly leveraged into IT capability building in order to enhance organizational agility. This might also explain some findings regarding the disabling role of IT for organizational agility, where the IT variable is primarily conceptualized as a IT resource in terms of investments, adoption, and an existence of an IT infrastructure; not considering the development of IT capabilities (Lu and Ramamurthy 2011; Overby et al. 2006). Second, the differentiation between operational and dynamic IT variables revealed a higher correlation for the latter (H3). While dynamic capabilities have been recognized as important for business value generation in general (e.g., Daniel et al. 2014; Pavlou and El Sawy 2011; Wang et al. 2012), we also show that they are crucial in achieving organizational agility. In order to appropriately seize and respond to changing environments, firms need to develop capabilities that continuously renew and adapt their information systems (Tiwana and Konsynski 2010). This might also explain contradictory positions in the literature. For example, Gosain et al. (2004) found that the standardization of process and content interfaces negatively impacts supply chain agility, thus concluding that it is more important to recognize how standards like electronic data interchange are adapted and being adaptable to change.

Regarding the level of analysis, we could not confirm our assumption that IT has a higher impact on process-level organizational agility compared to the firm-level. This is surprising since organizational agility heavily relies on intra- and interfirm business processes, which in turn heavily depend on the underlying IT infrastructure (Chen et al. 2014; Weill et al. 2002). Future theory development is necessary to understand the impact of IT on different levels of organizational agility. Contrary to our expectations, we did not find any significant effects of the respondent type, as there was no significant difference between matched-pair and single informant studies (H5). These results must be interpreted with caution, as our sample only consists of a few studies using matched pair designs. Nonetheless, future studies using matched pair surveys may provide additional insight into their usefulness. Interestingly, higher-ranked publications featured a lower correlation (H6). This is in contrast to the "file drawer problem" (Rosenthal 1979) which is a typical issue in meta-analyses. A reason might be that higher-ranked publications used more appropriate IT and agility constructs as well as advanced measurement instruments, which might have led to lower correlations.

### 2.5.2 Theoretical and practical implications

Our study contributes to existing research regarding the relationship between IT and organizational agility in several ways. First, we made a first step in integrating and synthesizing research on IT-enabled organizational agility. This could be a starting point for future studies as we also provide several directions for future research. Second, our results provide strong theoretical support for the RBV and dynamic capability theory for explaining how IT enables organizational agility. In a broader sense, this is important to better understand IT business value because organizational agility ultimately leads to a sustained competitive advantage (Lee et al. 2015; Sambamurthy et al. 2003) or can even be interpreted as an expanded IT value metric (Kohli and Grover 2008; Lu and Ramamurthy 2011). Third, our analysis created evidence for a generally positive relationship between IT and organizational agility, supporting among others the findings of Lu and Ramamurthy (2011). This indicates that the enabling role of IT for agility outperforms its disabling role and that there is not really a paradox in this research stream. Fourth, our results also indicate how future research studies could be designed regarding the relationship of IT and organizational agility. Researchers could focus on IT capabilities, in particular dynamic IT capabilities, because these variables are more suitable in explaining variances in agility than IT investments or adoption of IS. Furthermore, in contrast to other IS research fields (e.g., Gerow et al. 2014), matched pair design do not tend to result in smaller correlations, which should encourage scholars to employ such designs as they improve the reliability of the results (John and Reve 1982; Kyu Kim et al. 2011).

As the business environment becomes increasingly turbulent and companies are put under competitive pressure, constant adaptation and innovation is required (Chakravarty et al. 2013; Chen et al. 2014; Lu and Ramamurthy 2011). In this context, managers should be aware that organizational agility is a key capability in todays' business environment that is characterized by digitization (Overby et al. 2006; Sambamurthy et al. 2003; Tallon and Pinsonneault 2011). Our study concludes that IT is positively influencing the organizational agility of a company. Thus, managers that are faced by disruptive changes and a dynamic environment should try to increase IT resources and capabilities to foster organizational agility necessary for a quick adaptation. However, IT executives should not focus on IT investments alone but rather develop unique IT capabilities to enhance agility. Moreover, managers could particularly focus on dynamic IT capabilities thus providing the ability to seamlessly renew and reconfigure information systems for changing business needs. Furthermore, attention should be paid to both process- and firm-level agility.

### 2.5.3 Limitations and further research

The meta-analysis method offers several advantages like a quantitative synthesis of empirical findings, but it also involves a number of limitations. First, the integration of a large number of studies often implies simplification, a concern sometimes coined as "*apples and oranges*". Since studies often differ in terms of used instruments and procedures, the comparability may suffer (King and He 2005). This concern is particularly important since we included similar concepts like organizational flexibility in our data set. Moreover, our results should be verified with qualitative studies, to avoid the inherent sampling bias towards empirical studies in meta-analyses (King and He 2006). As a last methodological concern, the choice of a fixed effects model limits the generalizability of our findings, but is appropriate for conclusions relying on our data set (Overton 1998). Future research could use random effects to further confirm our results.

Our data set revealed several starting points for further research. First, an extended use of methods and measurement instruments could be useful for research on IT-enabled agility. We did not find any longitudinal studies in our review. However, agility is a long-term and dynamic capability, focusing on how firms can seize and respond to changing environments over time (Lee et al. 2015; Sambamurthy et al. 2003). Therefore, longitudinal studies would improve the validity of results and provide a deeper understanding of how IT capabilities and resources change in the long run to enhance agility. Moreover, IT investment and IT adoption effects might occur only after a period of time (Kohli and Grover 2008). Furthermore, the empirical studies did not include any secondary data in their studies. The development and use of objective measures for agility and IT variables could enhance the robustness and reliability of study results (Chau et al. 2007). Lastly, matched pair designs were underrepresented in our sample. The results of the moderator analysis reveal that a matched pair design probably does not dampen the relationship between IT and organizational agility. This should encourage researchers to collect data from multiple sources in order to reduce common method bias and improve reliability.

Second, the data analysis showed that the relationship between IT and organizational agility is generally positive. However, the literature also offers several arguments that would support a negative effect of IT. Legacy systems are often perceived as inflexible and difficult to change (Allen and Boynton 1991; van Oosterhout et al. 2006). Outsourcing trends distributed the development of large information systems over several vendors. As a result, adapting these systems to new requirements is complex and expensive (van Oosterhout et al. 2006). Positive effects of IT might overshadow these negative arguments. Therefore, future research should closely examine whether negative effects of IT on organizational agility are existing. A fine-grained model including different IT variables could examine for the negative effect of legacy systems or specific IT architectures on organizational agility, which may be surpassed by the positive effects of dynamic IT capabilities. Furthermore, this could provide insights into tensions between well developed and highly customized information systems and flexibility. For example, Saraf et al. (2007) investigate how IS integration and IS flexibility lead to business value, and thus how firms can handle this paradox. Moreover, our results provide strong theoretical support for the capability-development process. We therefore encourage researchers to consider the entire process of achieving agility, including IT resources, operational and dynamic capabilities, and performance as ultimate outcome.

Third, future research should develop a more granular and differentiated understanding of the agility concept. As we have already argued, it is important to note the two different components of agility. A majority of empirical studies analyzes IT-enabled adaptive agility, but we could only identify five studies that included the relationship between IT and entrepreneurial agility. This limited our possibilities for analyzing the impact of moderators on the different types of agility. For example, it would be beneficial to examine whether dynamic IT capabilities have a greater impact on entrepreneurial than on adaptive agility, as the former one requires fundamental changes to business processes and information systems (Sambamurthy et al. 2007). Therefore, future research should explicitly focus on this under-researched perspective. Moreover, Overby et al. (2006) suggested analyzing the alignment of sensing and responding capabilities. Firms that are either able to sense or to respond to changes cannot be regarded as agile. Therefore, companies should focus their sensing and responding capabilities on certain functional areas that are crucial for business success (Overby et al. 2006). The development of such an alignment measure would offer a promising opportunity for future research.

Fourth, contextual factors might influence the relationship between IT and organizational agility. Results from previous studies reveal that firms acting in turbulent environments gain higher value from IT-enabled agility than firms in stable environments (e.g., Chakravarty et al. 2013; Tallon and Pinsonneault 2011). It would therefore be valuable to investigate the influence of contextual variables, such as culture, industry type, governance mode, or type of interfirm relationship. For instance, studies found a significant influence of the economic region on the value of IT investments (e.g., Dedrick et al. 2013; Patrakosol and Lee 2009). However, our sample includes only studies that were conducted in developed countries. We therefore encourage researchers to conduct studies on IT-enabled agility in different contexts and to examine the resulting differences.

## 2.6 Conclusion

Our study integrated existing empirical results of the relationship between information technology and organizational agility to (1) verify the positive relationship between IT and agility, (2) to find moderators that explain differences in existing findings and (3) to synthesize different definitions and understandings of both constructs to facilitate further research. This topic is particularly important due to the ongoing digitization in the business environment, which requires organizations to constantly adapt to changing circumstances (e.g., Chakravarty et al. 2013; Loebbecke and Picot 2015). We developed and tested six different hypotheses applying a meta-analytic approach and found general support for the positive influence of IT on organizational agility, both to entrepreneurial and adaptive agility. In addition, our data supported the assumption that IT capabilities have a higher positive influence on organizational agility compared to IT resources. Moreover, dynamic IT variables featured a higher correlation with organizational agility than static IT variables. These results contribute to theory and practice by shedding light into the relationship of IT and organizational agility. Our study can also guide further research by providing a comprehensive overview of empirical research.

## 2.7 Appendix

*Table B-10. List of studies used for the meta-analysis*

| Reference | Sample size | Correlation(s) | Agility-type* | Country | Industry |
|---|---|---|---|---|---|
| (Arnold et al. 2015) | 155 | .648 | A | USA | Mixed |
| (Bhatt et al. 2010) | 105 | .650 | A | USA | Mixed |
| (Bi et al. 2012) | 310 | .317 | A | Australia | Mixed |
| (Breu et al. 2001) | 515 | .135, .264 | A | U.K. | Mixed |
| (Cai et al. 2013) | 131 | .290 | A | China | Mixed |
| (Chakravarty et al. 2013) | 109 | .320<br>.170 | E<br>A | USA | E-Commerce |

*Continued on Page 73*

*Continued from Page 72*

| | | | | | |
|---|---|---|---|---|---|
| (Chen and Siau 2012) | 214 | .220, .333 | A | USA | Mixed |
| (Chen et al. 2014) | 214 | .510 | A | China | Manufacturing |
| (da Silveira and Cagliano 2006) | 201 | .154 | A | Mixed | Manufacturing |
| (Degroote and Marx 2013) | 193 | .725 | A | USA | Manufacturing |
| (Fink and Neumann 2007) | 293 | .482, .507 | A | Israel | Mixed |
| (Gosain et al. 2004) | 41 | -.127 | A | USA | IT |
| (Kharabe et al. 2013) | 215 | .382, .406<br>.485, .515 | E<br>A | USA | Mixed |
| (Lee and Wang 2013) | 147 | .298 | A | Taiwan | Manufacturing |
| (Lee et al. 2008) | 205 | .493 | A | China | Mixed |
| (Lee et al. 2009) | 147 | .318 | A | USA | Service |
| (Lee et al. 2011) | 195 | .359 | A | USA | Mixed |
| (Lee et al. 2013) | 195 | .360 | A | USA | Mixed |
| (Lee et al. 2015) | 178 | .222<br>.303 | E<br>A | China | Mixed |
| (Ling et al. 2009) | 72 | .393 | A | China | Mixed |
| (Liu et al. 2013) | 286 | .520, .560 | A | China | Mixed |
| (Lu and Ramamurthy 2011) | 128 | .380, -.080 | A | USA | Mixed |
| (Martin et al. 2008) | 136 | .449 | A | Germany | Banking |
| (Ojha et al. 2015) | 206 | .375 | A | USA | Manufacturing |
| (Palanisamy 2003) | 296 | .351, .164 | A | USA | Mixed |
| (Pavlou and El Sawy 2010) | 180 | .320 | E | USA | Mixed |
| (Queiroz et al. 2015) | 141 | .430 | A | Mixed | Mixed |
| (Rai and Tang 2010) | 318 | .379, .395 | A | USA | Mixed |
| (Raschke 2010) | 273 | .310 | A | USA | Manufacturing |
| (Roberts and Grover 2012) | 188 | .340<br>.240 | E<br>A | USA | High-tech |
| (Saini and Johnson 2005) | 122 | .140 | A | USA | E-Commerce |
| (Skipper and Landrum 2008) | 50 | .521 | A | USA | Mixed |
| (Skipper et al. 2009) | 74 | .570 | A | USA | Mixed |
| (Swafford et al. 2006) | 135 | .099 | A | USA | Manufacturing |
| (Swafford et al. 2008) | 131 | .226 | A | USA | Manufacturing |
| (Tallon 2008) | 241 | .477 | A | USA | Mixed |
| (Tallon and Pinsonneault 2011) | 241 | .443 | A | USA | Mixed |
| (Tiwana and Konsynski 2010) | 223 | .124 | A | USA | Mixed |
| (Trinh 2015) | 224 | .430 | A | Mixed | Mixed |
| (Wang et al. 2013) | 144 | .224 | A | Taiwan | Manufacturing |
| (Youn et al. 2014) | 74 | .231 | A | South Korea | Manufacturing |

* Note: E = entrepreneurial agility; A = adaptive agility

## II. Theory Extension: Key Capabilities and Interdependencies of IT-Based Value Co-Creation Mechanisms

The previous chapter (B.I) integrated previous research findings by drawing on reference theories and analyzing contextual factors. Building upon this interim result, this chapter aims to extend the reference theories to the IS context by developing and adding new constructs, configurations, and logic. Therefore, key capabilities and interdependencies of IT-based value co-creation mechanisms are examined, providing answers to the second research question. Inter-organizational networks across different industries are taken as the unit of analysis.

Two studies are included in this chapter, each focusing on a particular theory referenced from strategic management literature. Study #3 aims to extend the relational view to capture IT-related phenomena of value co-creation. It provides new conceptualizations of the constructs and new hierarchical relationships between the factors. Study #4 adapts dynamic capability theory, and conceptualizes inter-organizational IT alignment as a higher-order dynamic IT capability. Furthermore, it integrates this construct in a nomological network with further inter-organizational IT capabilities. Both theoretical models developed in the two studies are validated by quantitative empirical investigations in regional networks in Germany.

# 1 Study #3: A Reconceptualization and Extension of the Relational View

*Table B-11. Fact sheet of Study #3*

| | |
|---|---|
| Title | IT-Based Value Co-Creation: A Reconceptualization and Extension of the Relational View |
| Authors | Markus Mandrella, mmandre@uni-goettingen.de* <br> Simon Thanh-Nam Trang, strang@uni-goettingen.de* <br> Sebastian Zander, szander1@uni-goettingen.de* <br> Lutz M. Kolbe, lkolbe@uni-goettingen.de* <br><br> *Georg-August-Universität Göttingen <br> Chair of Information Management <br> Platz der Göttinger Sieben 5 <br> 37073 Göttingen |
| Outlet | Information and Organization, 1st submission, Completed Research Paper |
| Abstract | This study sets out to adapt the relational view to the IS context to improve our understanding of how value can be cocreated through IT. We first reconceptualize the sources of relational value and identify two groups of constructs: digitally enabled interfirm capabilities and information-processing capabilities. We integrate these constructs in a nomological network and test the hypotheses with survey data. The results reveal that digitally enabled interfirm capabilities can be interpreted as the primary sources of value, thereby mediating the effect of information-processing capabilities. We therefore extend the relational value by providing new conceptualizations and reconfiguring the underlying logic. |
| Keywords | IT value co-creation; Relational view; Interfirm IT capabilities |

## 1.1 Introduction

In a highly competitive environment, firms are becoming increasingly dependent on external resources due to the focus on their core competencies. This bolsters the need for collaboration across organizational boundaries via interfirm relationships, which depend crucially on information technologies (IT), as they "provide the capacity to operate within the network of relationships" (Grant and Tan 2013). Inter-organizational systems (IOS) and their employment in and combination with organizational interfirm capabilities can lead to the co-creation of superior synergies and benefits for partners in interfirm relationships (Grover and Kohli 2012). For instance, innovation networks develop new products using the Internet of Things (Prince et al. 2014), automotive networks orchestrate their supplier and distribution channels with supply chain management solutions (Graham and Hardaker 2000), and payment networks coordinate billions of transactions via their common IT platforms (Markus and Bui 2012). However, challenges in interfirm collaboration, such as heterogeneous information systems and strategies, opportunistic behavior, and the distribution of co-created value, lead to high failure rates (Kohli and Grover 2008) of up to 50 percent (Gulati et al. 2012). Therefore, IS scholars strive to understand the contribution of IOS to business value in their support of interfirm relationships (Im and Rai 2014).

The research stream of IT-based value co-creation investigates how firms that are engaged in interfirm relationships can create business value through joint IT resources and capabilities (Grover and Kohli 2012). Studies often build on theoretical perspectives of the resource-based view (RBV) when examining the business value of IT investments (e.g., Mata et al. 1995; Wade and Hulland 2004). The relational view of the firm (Dyer and Singh 1998) extends the RBV to an interfirm level of analysis, postulating that (1) relation-specific assets, (2) complementary capabilities, (3) knowledge sharing, and (4) effective governance are sources of relational value. IS scholars have adapted the relational view as a reference theory to examine how IOS and interfirm IT capabilities lead to superior value (e.g., Malhotra et al. 2005; Rai et al. 2012; Saraf et al. 2007). Furthermore, this theory can be used to categorize and synthesize existing research on IT-based value co-creation (Grover and Kohli 2012; Mandrella et al. 2016). Despite the efforts made in this research stream, existing studies often make only minor to moderate changes to the relational view and treat the IT variable(s) as endogenous rather than being embedded in interfirm business activities (Grover and Lyytinen 2015). We argue that, in contrast to other organizational resources, IS have special characteristics in terms of an enabling function and value-creation mechanisms. This should then result in a new conceptualization of constructs and a reconfiguration of the logic of the relational view. Therefore, we aim to answer the following research questions: (1) How should the sources of relational value be conceptualized when applied to IS? (2) How should interdependencies between these factors and relational value be configured?

To answer these research questions, we empirically validate a theoretically derived research model. Based on theoretical lenses and findings from IT-based value co-creation research, we first conceptualize the four sources of relational value in the context of IS and identify two groups of IT constructs: (1) digitally enabled interfirm capabilities (i.e., IT-enabled interfirm integration and IT-enabled complementary capabilities) and (2) information-processing capabilities (i.e., IT-enabled information sharing and IT-enabled governance). Moreover, we argue that digitally enabled interfirm capabilities are the primary sources of relational value and that they mediate the effect of information-processing capabilities on relational value. A questionnaire-based survey among organizations in regional networks in Germany was conducted to test the research model. Thus, we provide two major theoretical contributions: first, we synergize existing literature through a more holistic view and thus provide a deeper understanding of how certain constructs should be positioned in a nomological network of IT-based value co-creation. Second, while previous research could be characterized as only “instantiating” or “modifying” the relational view (Grover and Lyytinen 2015), we extend the theory by proposing new conceptualizations and interdependencies based on specific characteristics of IS.

The remainder of the paper is organized as follows. First, we review the use of the relational view in IS research. We then present the reconceptualization of the relational view. Following this, the research model and hypotheses are developed. We then present the research design of our study, followed by the analysis and results of the empirical investigation. Finally, we discuss our research findings and the theoretical and managerial implications, address the study’s limitations, and offer an outlook for further research.

## 1.2 Previous IS Research Adapting the Relational View

*Table B-12. Quantitative IS studies adapting the relational view as a reference theory*

| Source of relational value | Study | Related IT Construct | Conceptualization of the IT construct | Treatment / Modeling of the IT construct |
|---|---|---|---|---|
| Relation-specific assets | Devaraj et al. 2007 | eBusiness Capabilities | Ability of a firm to use IT to support collaboration activities | Predictor of production information integration |
| | Klein 2007 | Client customization | Specialization of applications to facilitate information exchanges with partners | Moderator between relational sources and performance |
| | Saraf et al. 2007 | IS integration | Extent to which IS applications are connected with business partners | Predictor of knowledge sharing and process coupling |
| | Paulraj et al. 2008 | Information technology | Use of IT to support supply-chain activities | Predictor of inter-organizational communication |
| | Klein and Rai 2009 | IT customization | Specialization of applications to facilitate information exchanges with partners | Predictor of strategic information flows |
| | Sanders et al. 2011 | Buyer investment in IOIT | Use of connective IT in comparison to competitors, industry, and suppliers | Predictor of communication openness |
| | Hadaya and Cassivi 2012 | Supply chain collaborative systems use | Integration of supply chain processes by using IOS | Predictor of performance |
| | Chen et al. 2013 | Hospital–supplier IT integration | Extent to which IS applications are connected with business partners | Predictor of knowledge exchange and hospital-supplier integration |
| Knowledge-sharing routines | Malhotra et al. 2005 | Partner interface-directed IS | Use of IS to store, retrieve, manipulate, and interpret information from supply chain partners | Predictor of absorptive capacity |
| | Rai et al. 2012 | Interfirm communications for IT development | Exchange of knowledge, ideas, and opinions between buyer/supplier IT executives | Predictor of relational value and moderator of the relationship between interfirm IT capability profiles and relational value |
| | Lee et al. 2014 | IOS visibility | Extent to which SC-related information/ knowledge is visible through IOS | Mediator between relational sources and performance |
| Complementary resources and capabilities | Rai et al. 2012 | Interfirm IT capability profiles | IT functionalities that are implemented and used in combination with other business resources | Predictor of relational value |
| Effective governance | Prasad et al. 2013 | IT governance structures for alliances | Structures for IT-related decision-making in collaborative settings | Predictor of collaborative rent |

The relational view of the firm (Dyer and Singh 1998) is an organizational theory from the strategic management discipline and is an extension of the RBV. It states that a firm's resources and capabilities may span its boundaries and by combining them in a unique way and creating idiosyncratic interfirm linkages, firms can create relational value – a supernormal profit they would be unable to attain on their own. Dyer and Singh (1998) posit four sources of relational value: (1) Relation-specific assets refer to investments in assets that are specific to the interfirm relationship, such as closely located sites as well as customized tools or machineries. Another important source for relational value is (2) the synergetic combination of complementary resources and capabilities, which generates greater value than the sum of the individual resources and capabilities of each firm. Firms can also create relational value via (3) knowledge-sharing routines – regular patterns of inter-organizational interactions that enable the creation, transfer, and recombination of information and know-how. Finally, (4) effective governance mechanisms, such as legal contracts or mutual trust, generate relational value by reducing transaction costs and opportunistic behavior as well as by providing incentives for investing in the first three sources of relational value.

Inter-organizational IT can expand, create, or enable each of the sources of relational value (Grover and Kohli 2012). In this context, the relational view has been adapted as a reference theory in various IS studies in order to understand how value can be co-created through IT. These studies have adapted one or more of these sources to the IS context and examined their relationship with other non-IT sources as well as their relational value. For example, Prasad et al. (2013) analyze how value can be co-created by establishing joint IT governance structures in collaborative alliances. Table B-12 summarizes representative empirical studies adapting the relational view, showing that scholars have investigated the role of inter-organizational IT in relation to different sources of relational value while using various conceptualizations and modeling of the IT construct.

All these studies examine important aspects of IT-based value co-creation. However, most of the studies adapt one of the sources of relational value to the context of IS, but make no or only minor changes to the concepts and logic of the underlying theory. Moreover, most IT-related constructs are treated either endogenous to the theory (e.g., IT investments) or only differ marginally from the original constructs of the relational view (e.g., IT governance). In these studies, there is only little IT-specific argumentation and theorizing. For example, Chen et al. (2013) interpret IT integration as a relation-specific asset and place it in a nomological network with knowledge exchange and trust (representing governance) to predict supply chain performance through hospital-supplier integration. In this case, IT integration is not a new construct, but just a specific type of relation-specific assets. Moreover, there is no change in the underlying logic of the theory. We found only a few studies which extend the relational view by providing new constructs and relationships in the IS context. For example, Rai et al. (2012) develop two IS-specific constructs: IT capability profiles (complementary capabilities) and interfirm communications (knowledge-sharing routines). Thereby, they add a new configuration to the relational view, i.e. by proposing that the relationship between IT capability profiles and relational value is moderated by interfirm communication. However, these studies focus on few sources of relational value or specific contexts, such as the investigated industry. To the best of our knowledge, no study has systematically conceptualized and examined all four sources and their interdependencies in the IS context. In the following, we argue that is important to consider the special characteristics of IS in the context of the relational view to capture IT-based phenomena and extend the understanding of the theory for the IS context. This leads to new conceptualizations and interdependencies between the constructs.

## 1.3 Reconceptualization of the Relational View

The relational view states that relation-specific assets are a source of relational value and assume an influence of effective governance on the other sources as the only interdependency (Dyer and Singh 1998). We argue that IS have special characteristics and therefore the relational view and its concepts should be rethought and extended. One unique characteristic of IS in this context is that they represent both relation-specific assets and act as enablers for all four sources of relational value (Grover and Kohli 2012). For example, partner-interface-direct information systems enhance interfirm knowledge sharing (Malhotra et al. 2005) and e-business systems facilitate the digitalization of interfirm business processes (Zhu et al. 2015). Moreover, an integrated IT infrastructure can be an enabler for all four sources of relational value (Grover and Kohli 2012). The second unique characteristic is that IT assets – in contrast to relation-specific assets as characterized by Dyer and Singh (1998) – do not necessarily lead to value. Based on the RBV, IS scholars argue that IT assets are widely available on the market and can be easily imitated by other firms (Mata et al. 1995; Wade and Hulland 2004). The effect of IT on business value is rather mediated by developing unique higher-order capabilities that combine IT resources with other organizational resources and capabilities (Barua et al. 2004; Bharadwaj 2000; Wade and Hulland 2004). These two unique characteristics of IS change (1) how the sources of relational value should be conceptualized when related to IS and (2) how interdependencies between the constructs must be configured.

### 1.3.1 IT-enabled sources of relational value

We build on three theoretical lenses to consider these special characteristics of IS in our reconceptualization. First, our study draws upon the distinction among IT resources and their deployment and mobilization with other organizational resources to create IT capabilities (e.g., Bharadwaj 2000; Wade and Hulland 2004). Accordingly, as inter-organizational IT resources per se do not necessarily lead to relational value, we conceptualize the four IT-enabled sources of relational value as IT capabilities. IOS are interpreted as the underlying and enabling technology, which, when combined with other inter-organizational resources, develop these capabilities. Second, our conceptualization is informed by the concept of appropriation (Subramani 2004), which states that different patterns of IT use lead to diverse outcomes, even when the technologies and context of use remain the same. In the context of our study, the use of IOS within interfirm partnerships enables each of the four sources of relational value. Third, we draw on the embedded view of IT by Kohli and Grover (2008), who note that IT is deeply embedded in organizational processes and should, therefore, not be separated from organizational capabilities when analyzing the impact on business value. Therefore, we do not separate inter-organizational IT investments and resources, but focus on capabilities where IT is an integral part of inter-organizational processes and structures. Thus, integrating these perspectives, we interpret inter-organizational IT resources, i.e., IOS, as the underlying technology embedded in and used to enable the four sources of relational value.

*Table B-13. Construct definitions*

| Source of Relational Value | IT Construct | Definition | Informing Sources |
|---|---|---|---|
| **Digitally enabled interfirm capabilities** | | | |
| Relation-specific assets | IT-enabled interfirm integration | The extent to which a firm has integrated its business activities with its partners in interfirm relationships by using inter-organizational systems. | Barua et al. 2004; Devaraj et al. 2007; Rai et al. 2015; Subramani 2004 |
| Complementary resources and capabilities | IT-enabled complementary capabilities | The extent to which a firm identifies, exploits, and leverages complementary capabilities and resources among partners in interfirm relationships by using inter-organizational systems. | Grover and Kohli 2012; Rai et al. 2012; Dong et al. 2009 |
| **Information-processing capabilities** | | | |
| Knowledge-sharing routines | IT-enabled information sharing | The extent to which tactical and strategic information is exchanged with partners in interfirm relationships using inter-organizational systems. | Barua et al. 2004; Lee et al. 2014; Malhotra et al. 2005 |
| Effective governance | IT-enabled governance | The extent to which partners in interfirm relationships collaborate to plan, control, and make decisions using inter-organizational systems. | Wang et al. 2013; Wong et al. 2015; Im and Rai 2014 |

Based on the above theorizing and a synthesis of research on IT-based value co-creation, we conceptualize four constructs that represent the four sources of relational value enabled by inter-organizational IT. The construct definitions are presented in Table B-13.

**IT-enabled interfirm integration:** IOS enable digital connections in interfirm relationships through a higher level of interfirm integration (Rai et al. 2015). In our context, integration refers to the extent to which business activities with partners are enabled by the use of IOS, including the operational support of interfirm efficiencies, development of new physical and digital products, services, and enhancements, as well as finding new business opportunities (Grover and Kohli 2012; Qrunfleh and Tarafdar 2014; Subramani 2004). IOS not only enable integration by digitalizing and supporting interfirm business activities, but also because IT increases the transparency of asset usage and therefore may serve as a safeguard (Grover and Kohli 2012).

**IT-enabled complementary capabilities:** IT functionalities that synergistically complement each other lead to IT-enabled complementary capabilities – the technical ability to identify, exploit, and leverage the complementary capabilities and resources of partner firms (Grover and Kohli 2012). In this case, a company can leverage its partner's resources by providing an IT-based skill or resource. For example, one company could have strong capabilities in design and marketing, while its partner developed advanced manufacturing capabilities (Scott 2000). IOS can improve communication between both firms, for example, by overcoming language barriers and thus enabling them to identify and leverage these complementary capabilities to jointly bring high quality products to the market.

**IT-enabled information sharing:** IOS functionalities, such as knowledge repositories or common databases (Grover and Kohli 2012), or whole IOS for information exchange (Malhotra et al. 2005) enable capabilities of information sharing in interfirm relationships. This involves both tactical information, which can be easily codified and transferred, and strategic information, which is more complex and difficult to structure (Barua et al. 2004; Dyer and Singh 1998).

**IT-enabled governance:** Finally, IOS can enable effective governance mechanisms. Specifically, partners collaborate to match each other's plans to enable joint planning, control their daily business operations and decisions, and make joint decisions related to their interfirm business activities (Hadaya and Cassivi 2012; Wang et al. 2013; Wong et al. 2015). As these activities are typically information and knowledge-intensive, IOS are used to process information, e.g., by combining and interpreting warehouse data from multiple partners to support managerial decisions (Im and Rai 2014). These IT-enabled capabilities match effective governance mechanisms as proposed by Dyer and Singh (1998) since they serve as self-enforcing safeguards, resulting in less opportunistic behavior of partners in interfirm relationships (Grover and Kohli 2012; Wang et al. 2013).

These four constructs depart from past research as they consider the special characteristics of IS. Therefore, IT is an integral part of each construct, enabling all four sources of relational value. This is important, since we aim to analyze IT-based phenomena when adapting the relational view to the IS context. Moreover, this conceptualization is more holistic than that in past research. While previous studies only adapted one or two sources to the IS context and focused on specific technologies and relationships, our conceptualization encompasses a consistent definition of all four IT-enabled sources of relational value.

### 1.3.2 Digitally enabled interfirm capabilities and information-processing capabilities

The above discussion clarifies the four IT-enabled sources of relational value. We now analyze the interdependencies between the constructs. To do so, we posit that IT-enabled integration and IT-enabled complementary capabilities represent digitally enabled interfirm capabilities, while IT-enabled information sharing and IT-enabled governance represent information-processing capabilities. We discuss their role and importance in the following.

Digitally enabled interfirm capabilities refer to higher-order organizational capabilities that are enabled by the use of IOS (Barua et al. 2004; Rai et al. 2006). These capabilities can either be improved or refined (exploitation) or developed anew (exploration) through IS (Im and Rai 2014; Subramani 2004). Here the term “digitally enabled” means that firms improve or develop interfirm operations and business activities through information-based connection and integration, contrary to traditional approaches of direct connections of physical processes (Dong et al. 2009). In the context of our study, this happens through a higher level of interfirm integration or the identification, exploitation, and leverage of complementary capabilities. Information-processing capabilities refer to the ability to capture, interpret, and synthesize appropriate information for dealing with uncertainties (Huang and Pan 2014; Tushman and Nadler 1978). IOS have the ability to support and enable information and knowledge-based activities across firm boundaries and therefore process information effectively (Huang and Pan 2014; Wang et al. 2013). Both types of information-processing capabilities in our conceptualization represent such information and knowledge-intensive activities, i.e., sharing of tactical and strategic information and planning, control, and decision-making through IOS.

Digitally enabled interfirm capabilities and information-processing capabilities have separate but complementary roles and satisfy a necessary but insufficient condition to enhance relational value. For instance, firms cannot create digital interfirm capabilities without first capturing, interpreting, and synthesizing information, e.g., by exchanging production and sales information. Similarly, digitally enabled interfirm capabilities, e.g., just-in-time assembly of customized orders, cannot be realized without first processing the needed information. Therefore, highly developed information-processing capabilities do not necessarily lead to relational value. Digitally enabled interfirm capabilities, however, involve exploiting the processed information by incorporating it into interfirm business activities, thereby leading to relational value. These arguments also match the concept of absorptive capacity, which refers to the capability of acquisition, assimilation, transfer, and exploitation of information (Malhotra et al. 2005). Absorptive capacity is usually conceptualized as a process, where the application and exploitation of information ultimately leads to economic outcomes (Roberts et al. 2012). In our context, information-processing capabilities enable the identification, assimilation, and transformation of information. However, the value-generating exploitation of information – for example, in digitalized business processes and products – happens through digitally enabled capabilities.

The theoretical distinction between digitally enabled interfirm capabilities and information-processing capabilities is important in analyzing their unique effects on relational value. It helps explain why certain interfirm partnerships are more efficient than others in co-creating value. Despite the important role of information-processing capabilities, digitally enabled interfirm capabilities are the primary source of relational value. Distinguishing between these two concepts shows that some interfirm partnerships fail in realizing relational value due to inefficient leveraging of information-processing capabilities. Moreover, it shows that the two groups of capabilities contribute to relational value in different ways.

## 1.4 Research Model

We re-conceptualized the four IT-enabled sources of relational value and categorized them into digitally enabled interfirm capabilities (i.e., IT-enabled interfirm integration and IT-enabled complementary capabilities) and information-processing capabilities (i.e., IT-enabled information sharing and IT-enabled governance). Moreover, we argued that digitally enabled interfirm capabilities are the primary source of relational value. We are now developing a research model and individual hypotheses regarding this conceptualization. Accordingly, we argue that the two information-processing capabilities facilitate digitally enabled interfirm capabilities and have only an indirect effect on relational value. We therefore do not consider a direct effect of the information-processing capabilities on the outcome variable. The research framework and model are presented in Figure B-3.

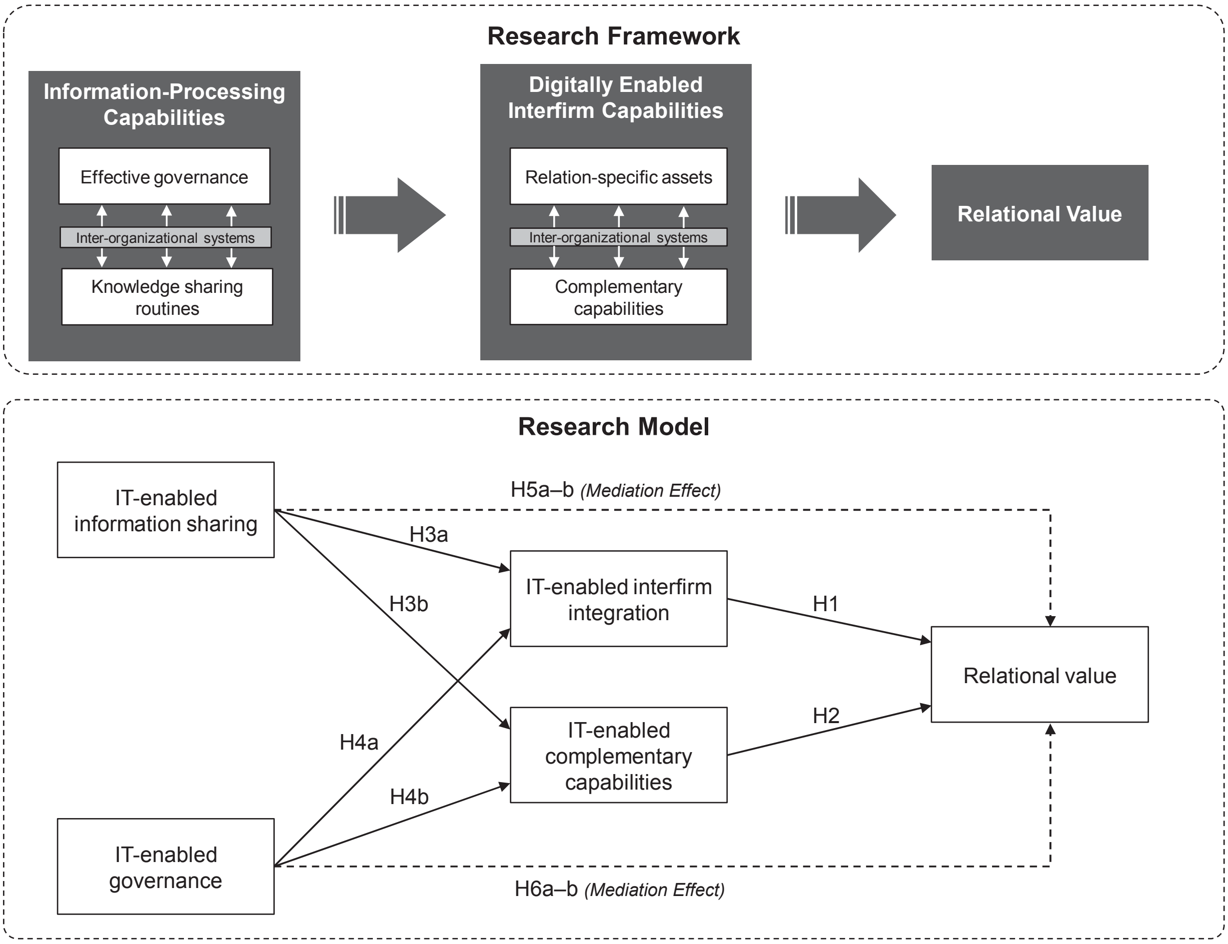


*Figure B-3. Proposed research framework and research model*

We examine relational value as the outcome variable in our research model. IT business value scholars argue that IT impacts should be assessed at the specific domain of interest where immediate effects are expected (Klein and Rai 2009; Ray et al. 2005). In our context, we aim to examine superior benefits resulting from collaboration in interfirm relationships. Therefore, relational value is the appropriate outcome variable and is also consistent with the relational view as well as previous research on IT-based value co-creation (e.g., Rai et al. 2012). Value in our context both includes tangible performance dimensions, such as reduced operational costs, and intangible measures, such as improvements in the launch of new products (Im and Rai 2014).

### 1.4.1 Digitally enabled interfirm capabilities as primary sources of relational value

We argue that IT-enabled interfirm integration leads to relational value through the mechanisms of exploitation and exploration. Regarding IS-induced exploitation, the adoption of IOS corresponds with the refinement of interfirm processes as they become more standardized, structured, and automated (Bala and Venkatesh 2007; Im and Rai 2014). For example, the use of supply chain management systems to make direct-to-store deliveries requires that production and inventory processes be more flexible, which entails reconfiguration by suppliers (Subramani 2004). These digitalized interfirm processes are characterized by improved coordination between networked firms and reduced uncertainties. In supply chains, for example, IOS can reduce communication errors, out-of-stock situations, and order fulfillment errors while also increasing inventory turnover rates (Barua et al. 2004; Lee et al. 2014). Furthermore, transaction costs can be lowered by having a smaller sales force, less paperwork, and fewer data input errors (Rai et al. 2015). Regarding IS-enabled exploration, network partners become aware of weaknesses and potential improvements of their interfirm processes (Subramani 2004). The resulting optimization and tighter integration of these processes not only fosters improved process efficiency, but also leads to more relation-specific and synchronized business activities. Such digitally enabled process capabilities are highly customized for the relationship and therefore cannot be duplicated by competitors, leading to value for partners in interfirm relationships (Im and Rai 2014; Subramani 2004). As such, these digitally enabled capabilities represent relation-specific assets and idiosyncratic linkages as described by Dyer and Singh (1998). In addition, IT-enabled interfirm integration through exploration can lead to new business opportunities, such as access to new markets, customer segments, and the creation of new business processes (Barua et al. 2004; Zhu and Kraemer 2005). Therefore, we propose a first hypothesis:

**Hypothesis 1 (H1):** IT-enabled interfirm integration is positively related to relational value.

IS research has paid less attention to IT-enabled complementary capabilities as sources of relational value. However, existing studies (e.g., Jeong et al. 2009; Rai et al. 2012; Subramani 2004) indicate that IT-enabled complementary capabilities lead to relational value. IOS enable greater connectivity and communication between partners in interfirm relationships, which allow them to identify and exploit resources and capabilities that are available only from the partners and not on secondary markets (Hadaya and Cassivi 2012; Zhu and Kraemer 2002). We argue that IT-enabled exploitation and exploration are again the mechanisms for co-creating value. As explained in Hypothesis 1, IOS lead to exploitation through the reconfiguration of interfirm business processes. This also enables companies to better understand the internal business processes of their partners and leverage this knowledge for the improvement of internal and external processes (Subramani 2004). Reporting and messaging functionalities have a particularly strong capacity to enable digitalized exploration capabilities (Subramani 2004). For example, firms complement their IT capabilities to develop a platform that integrates knowledge about customers, leading to superior and synergetic value effects (Sarker et al. 2012). Furthermore, in both cases, the potential value of legacy systems can be enhanced by, for example, connecting various old databases (Zhu and Kraemer 2002). Therefore, we propose the following hypothesis:

**Hypothesis 2 (H2):** IT-enabled complementary capabilities are positively related to relational value.

### 1.4.2 Linking information-processing capabilities and digitally enabled interfirm capabilities

Having theorized the digitally enabled interfirm capabilities as primary sources of relational value, we now explain the role of the information-processing capabilities (i.e., IT-enabled information sharing and IT-enabled governance). We first interpret these two capabilities as antecedents of digitally enabled interfirm capabilities and develop hypotheses regarding their influence on IT-enabled interfirm integration and IT-enabled complementary capabilities. Then, we develop mediation hypotheses to explain why the information-processing capabilities have only an indirect effect on relational value.

IOS improve information flows between partners in interfirm relationships in the following ways: First, they make large amounts of data scalable and thus provide the infrastructural basis for the transfer and processing of information (Barua et al. 2004; Wong et al. 2015). Second, IOS reduce technical barriers and provide seamless access to data, leading to increased, more accurate, and timelier information exchange among network partners (Kim et al. 2006; Roberts and Grover 2012). Third, standardized information exchange through IOS reduces coordination costs, thereby providing the resources and facilitating the transfer of higher value–adding and strategic information (Malhotra et al. 2005). This increased level and higher quality of information exchange enabled by IOS provides network partners with the conditions for developing higher-order digitalized capabilities (Malhotra et al. 2005). In turn, this creates favorable conditions for IT-enabled integration: better availability and exchange of information between firms can be leveraged to innovate new or refine existing digitalized products, services, and processes (Im and Rai 2008) as well as to better synchronize resource allocations (Klein and Rai 2009). For example, the technical ability to share rich and timely information between customers and suppliers enables them to implement and use online-based transactions instead of traditional methods, such as telephone interactions (Barua et al. 2004). At the same time, the improved information exchange enhances IT-enabled complementary capabilities, as the information can be used to build new associations and linkages between firms (Im and Rai 2008; Klein 2007; Klein and Rai 2009). Moreover, better information flows lead to inter-organizational learning (Prasad et al. 2013), mutual understanding (Im 2006), and coordination (Barua et al. 2004; Wong et al. 2015) in interfirm relationships, which represent important capabilities that foster the development of higher-order digitalized interfirm capabilities. Furthermore, IT-enabled information sharing increases transparency and thus reduces opportunistic behavior in interfirm relationships (Chi and Holsapple 2005), thereby enhancing the willingness to develop joint capabilities, such as IT-enabled integration and complementary capabilities. Therefore, we propose the following two hypotheses:

**Hypothesis 3a (H3a):** IT-enabled information sharing is positively related to IT-enabled interfirm integration.

**Hypothesis 3b (H3b):** IT-enabled information sharing is positively related to IT-enabled complementary capabilities.

IOS enable interfirm governance in the form of improved planning, control, and decision making through the real-time transfer of information, such as supply chain plans (Wang et al. 2013). Furthermore, they facilitate the exchange of information necessary for decision making and improve the visibility of decisions (Wong et al. 2015). This encourages partners in interfirm relationships to develop digitally enabled capabilities for the following reasons. First, due to more frequent interactions, interdependencies in interfirm relationships intensify, which increases the need and incentive to invest in relation-specific business activities (Wang et al. 2013). Second, improved information processing allows network partners to synchronize their heterogonous plans and goals and thus to better utilize internal and external resources (Wang et al. 2013). Therefore, it results in more effective and efficient decisions regarding investments in IOS for the support of interfirm integration and the exploitation of complementary capabilities (Hadaya and Cassivi 2012). Third, IT-enabled decision making improves communication among supply chain partners, which is important for building higher-order digitalized capabilities (Lai et al. 2008; Wong et al. 2015). The theoretical perspectives of the relational view further support these arguments. According to Dyer and

Singh (1998), self-enforcing safeguards, such as financial hostages or trust, are more effective governance mechanisms than formal arrangements, such as legal contracts. As described in the conceptualization, IT-enabled governance capabilities serve as safeguards, resulting in more intense collaborative management and less opportunistic behavior (Grover and Kohli 2012; Wang et al. 2013). Hence, it increases the willingness and provides incentives to engage in interfirm value-adding initiatives, including the development of digitally enabled capabilities (Lee et al. 2014; Prasad et al. 2013). Therefore, we propose the following two hypotheses:

**Hypothesis 4a (H4a):** IT-enabled governance is positively related to IT-enabled interfirm integration.

**Hypothesis 4b (H4b):** IT-enabled governance is positively related to IT-enabled complementary capabilities.

We now propose that, moreover, the relationship between the information-processing capabilities and relational value is mediated by the digitally enabled interfirm capabilities. We argue that the ability to capture, interpret, and synthesize does not lead to superior value for partners in interfirm relationships unless it is leveraged in higher-order digitally enabled interfirm capabilities. For instance, shared information in interfirm relationships does not lead to relational value unless it is exploited in business processes, new products and services, or complementary organizational capabilities (Kim et al. 2006). Similarly, plans developed and decisions made through the use of IOS must finally be implemented in interfirm business activities (Wang et al. 2013). For example, the elimination of the bullwhip effect is a prominent phenomenon in supply chains, where inventory fluctuations lead to critical inventory buildup further up the supply chain (Lee et al. 1997; Zhu and Kraemer 2005). It is argued that an improved and coordinated upstream information flow enabled by IOS can reduce this bullwhip effect (Lee et al. 2014). However, economic outcomes for supply chain partners, such as lower operation costs and faster order-fulfillment processes, are ultimately realized when the improved information flow is used to refine and optimize supply chain processes with the use of IOS (IT-enabled interfirm integration). Moreover, sharing customer-related information along the supply chain can help suppliers improve their products according to customer preferences (IT-enabled complementary capabilities). Therefore, we finally propose four mediation hypotheses:

**Hypothesis 5a (H5a):** IT-enabled interfirm integration positively mediates the relationship between IT-enabled information sharing and relational value.

**Hypothesis 5b (H5b):** IT-enabled complementary capabilities positively mediate the relationship between IT-enabled information sharing and relational value.

**Hypothesis 6a (H6a):** IT-enabled interfirm integration positively mediates the relationship between IT-enabled governance and relational value.

**Hypothesis 6b (H6b):** IT-enabled complementary capabilities positively mediate the relationship between IT-enabled governance and relational value.

## 1.5 Research Design

### 1.5.1 Measures

The survey instrument was developed based on a comprehensive review of appropriate measurement scales for the theoretical constructs. Measurement items were chosen carefully based on their consistency with our construct definitions (see Table B-13), measurement quality, and use in other studies. IT-enabled integration was measured on a 4-item scale, reflecting the level of integration of business activities in interfirm partnerships, i.e. the efficiency of operations, development of new business opportunities, products, and services, along with safeguarding against opportunism (Grover and Kohli 2012; Subramani 2004; Westergren and Holmström 2012). Consistent with the definition in our study (see Table B-13), we measured IT-enabled complementary capabilities on a 3 item reflective scale which includes the identification, exploitation, and leverage of complementary resources and capabilities among partners (Grover and Kohli 2012). The items were supplemented with explanations and examples of complementary capabilities to provide a common understanding among the participants. For IT-enabled information sharing, a 4 item scale was adapted by Li and Lin (2006), reflecting the extent and quality of information sharing enabled by IOS, including proprietary information. IT-enabled governance was measured with 4 items adapted from Chan et al. (2006) and Sabherwal and Chan (2001), which reflect decision-making, planning, and control enabled by IOS. Finally, relational value was measured on a 5 item scale adapted by Im and Rai (2014), reflecting tangible performance dimensions, i.e., reduced operational costs, increased sales, and faster order fulfilment, but also intangible measures, i.e., improvements in the service quality and the launch of new products.

As the sampling frame consists of only German-speaking organizations, the measurement scales were translated into German by the authors. As major adjustments were necessary, an item-sort task was conducted to pretest and assess the construct validities (Anderson and

Gerbing 1991). A panel of ten experts from academia and practice were asked to allocate the randomly sorted items to the respective constructs and their definitions. The results indicate a good level of construct validity (proportion of substantive agreement > .90 and substantive-validity coefficient > .80 with $p < .01$ for all items). Building upon these results, the questionnaire was developed. All items were measured using multi-item scales with seven-point Likert rating systems. Three academic researchers reviewed the questionnaire for structure, ambiguity, clarity, and completeness, resulting in layout modifications and minor rewordings to improve clarity. The measurement scales are summarized in the Appendix (Table B-19).

To ensure methodological rigor, we specified network duration, area of cooperation, industry, and reveneue as control variables for relational value for the following reasons: First, partners in long-term interfirm relationships have advantages regarding the development of routines and building of knowledge for co-creating IT capabilities to enhance business value (Im and Rai 2014). Second, IT usage and maturity can differ between both areas of cooperation and industries, thus potentially influencing business value gains through IT (Hitt et al. 2002). Third, firm size in terms of annual revenue plays a critical role in building interfirm IT capabilities, as larger firms might enjoy scale efficiencies (Zhu and Kraemer 2005).

### 1.5.2 Sample, descriptive statistics, and data screening

We chose regional networks as types of interfirm relationships and our unit of analysis. A regional network is a set of organizations that cooperate to achieve common goals, such as developing joint products or establishing common marketing activities. They are characterized by their local proximity and a common social milieu (Sydow and Duschek 2011) as well as long-term reoccurring and high-trust relationships (Provan and Kenis 2007). Regional networks represent an appropriate target population because their stable and trust-based relationships allow for a high degree of IT use (Klein and Rai 2009), and they are highly heterogeneous in terms of their forms and characteristics (Bell et al. 2009), allowing for better generalizability of the empirical results.

A web-based survey questionnaire was developed to collect data between May and August 2014. The link was distributed among companies cooperating in interfirm relationships in regional networks in Germany that were listed on Cluster Observatory,[5] an online database for regional network clusters in Europe. The questionnaire was published and advertised online. The respondents were instructed to answer the questionnaire in reference to the network that

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[5] http://www.clusterobservatory.eu/.

was obtained from Cluster Observatory. If participants were cooperating in several networks, they were asked to refer to the network relationship with which they are most familiar. Participants were provided with a brief description and examples of IOS so that they have a common understanding of the same. This resulted in a total of 160 completed questionnaires, 8 of which were discarded because of invalid answers regarding the implausibility of demographics or network characteristics. In summary, the sample consists of 152 firms. The sample characteristics are provided in Table B-14.

*Table B-14. Sample characteristics*

| **Firm Characteristics** | | **Network Characteristics** | | **Respondent Characteristics** | |
|---|---|---|---|---|---|
| **Number of employees** | | **Area of cooperation** | | **Position** | |
| <50 | 50 % | R&D | 72 % | CEO / Managing director | 55 % |
| 50–250 | 24 % | Procurement | 18 % | Line manager | 13 % |
| >250 | 26 % | Operations | 21 % | CIO | 5 % |
| **Revenue** (in million euros) | | Logistics | 11 % | Other | 27 % |
| <10 | 52 % | Sales | 28 % | | |
| <50 | 20 % | Marketing | 33 % | | |
| >50 | 28 % | Service | 14 % | | |
| | | Other | 14 % | | |

Because we employed a single-informant approach, we applied two common methods to assess the threat of common method variance (CMV). First, Harman's single-factor test was performed to test for a common factor (Podsakoff 1986). All measurement items used in the investigation were subjected to an exploratory factor analysis. The results show that no factor accounted for most of the variance (<34.874%), which is a first indication that common method bias is not a serious problem. Second, we employed the marker variable technique (Lindell and Whitney 2001), choosing respondent's managerial level as the theoretically unrelated marker variable (Im and Rai 2014). The highest variance the marker shares with any other focal construct is below .03. Moreover, the adjusted correlations among the focal constructs reveal no major change in magnitude (>.01 and not significantly). The results collectively provide evidence that CMV is not a major threat with our data.

## 1.6 Data Analysis and Results

In order to test the theoretical model and our hypotheses, we used a structural equitation modeling (SEM) approach. We decided to apply the partial least squares (PLS) method as it has fewer demands for sample size and excels at prediction. Furthermore, normal distribution is not required (Ringle et al. 2012). Our sample of 152 cases satisfies the heuristic that the sample size should exceed 10 times the number of paths directed to any latent variable in the model (Chin 1998). The analysis was supported using the software SmartPLS 2.0.M3. In addition, SPSS Statistics 21 was used for tests that are not available within the SmartPLS package. We followed the widely adopted two-step approach for SEM: Fist, we assess the quality of the measurement model in order to ensure validity and reliability. Subsequently, the structural model is analyzed (Anderson and Gerbing 1988). This involves an estimation of the proposed research model (basic research model) and hierarchical regressions in order to test the mediation hypotheses.

### 1.6.1 Measurement model

To assess the fit of the research model and empirical data, the reflective constructs were tested for content, convergent, and discriminant validity. All test results reported in Table B-15 are based on the PLS estimation for the basic research model (research model without partial mediating effects). However, the requirements for the measurement models of all other further computations have also been met.

*Table B-15. FL, CR, AVE, and inter-construct correlations*

| | FL | AVE | CR | IN | CO | IS | GO | RV |
|---|---|---|---|---|---|---|---|---|
| IN | .745–.824 | .613 | .863 | **.783** | | | | |
| CO | .854–.923 | .796 | .921 | .637 | **.796** | | | |
| IS | .733–.832 | .632 | .873 | .685 | .554 | **.795** | | |
| GO | .848–.882 | .744 | .921 | .676 | .460 | .591 | **.744** | |
| RV | .750–.886 | .665 | .908 | .675 | .509 | .536 | .631 | **.815** |

*FL: Factor loadings; AVE: average variance extracted; CR: composite reliability. IN: IT-enabled interfirm integration; CO: IT-enabled complementary capabilities; IS: IT-enabled information sharing; GO: IT-enabled governance. Bolded numbers: square root of AVE.*

We assured content validity by using existing scales from related research that fit our theoretical constructs; by conducting item-sorting tasks with experts from academia and practice; and by having the questionnaire reviewed by academic experts. Furthermore, three measures were evaluated to offer evidence of convergent validity: individual item reliability, composite construct reliability (CR), and average variance extracted (AVE). All items load on their respective constructs at .70 or above, indicating an acceptable level of individual item reliability (Gefen and Straub 2005). The CR varies between .863 and .921, which is also above the acceptable limit of .70 (Hulland 1999). Convergent validity refers to whether items measuring a construct correspond with one another. The average variance extracted (AVE) of each construct exceeds the lower bound of .50 (Bhattacherjee and Premkumar 2004). Discriminant validity refers to whether theoretically distinct concepts are empirically distinct from one another. We checked cross-loadings and, as expected, all items have higher loadings on their assigned construct than on the other constructs in the model (Chin 1998). Moreover, we used the criterion of Fornell and Larcker (1981): As the AVE for each construct is greater than the variance shared with other constructs (see square root of AVEs on the diagonal in Table B-15), discriminant validity can be confirmed. Hence, the analyses suggest that our measurement model is both acceptable and reliable.

### 1.6.2 Structural model

We computed four configurations of structural models in order to test our hypotheses (see Table B-16). A first model only estimated relational value with all controls (Model 1). A second estimation involved the basic research model as depicted in Figure B-4 (Model 2). A third and fourth estimation included direct paths of the information processing capabilities on relational value for further mediation analyses (Model 3 and Model 4).

To compute inference statistics for the path coefficients of the model estimations, we used a bootstrapping re-sampling procedure with 5000 samples, as this is the preferred method when the sample size is greater than 100 (Kock 2011). We additionally computed the Stone-Geisser $Q^2$ coefficient with a blindfolding procedure to determine the predictive relevance of the structural model. All $Q^2$ values lie clearly above the minimum threshold of 0, indicating the overall predictive relevance (Chin 1998).

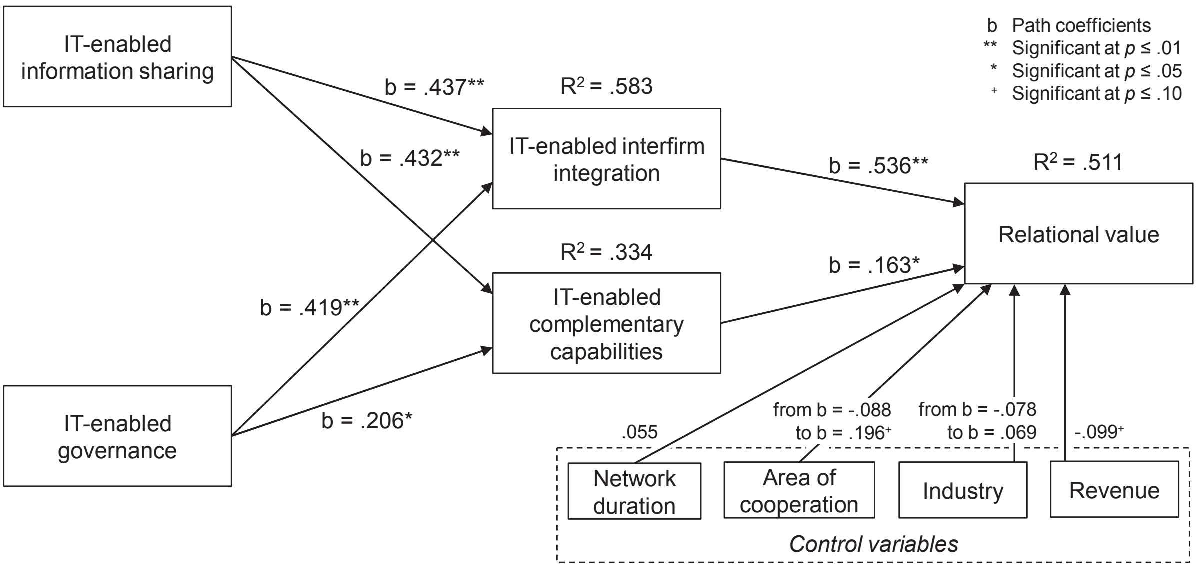



*Figure B-4. PLS results of the structural model (basic research model)*

The estimates of the path coefficients as well as the significance levels of the bootstrapping procedure for the basic research model are presented in Figure B-4. The structural model indicates that relational value is positively and significantly influenced by both IT-enabled interfirm integration (b = .536, $p \leq .01$) and IT-enabled complementary capabilities (b = .163, $p \leq .05$). Furthermore, the results also demonstrate that these interfirm capabilities as primary sources of relational value are enabled by information-processing capabilities in terms of IT-enabled information sharing (b = .437, $p \leq .01$ and b = .432, $p \leq .01$) and IT-enabled governance (b = .419, $p \leq .01$ and b = .206, $p \leq .05$).

*Table B-16. Results of the hierarchical PLS-based regression with dependent variable relational value*

| | **Model 1** (controls only) | **Model 2** (primary sources) | **Model 3** (primary sources + IS) | **Model 4** (primary sources + GO) |
|---|---|---|---|---|
| **IT Constructs** | | | | |
| IN | | .536** | .474** | .367** |
| CO | | .163* | $.142^{+}$ | $.143^{+}$ |
| IS | | | .117 | |
| GO | | | | .259** |
| **Controls** | | | | |
| Network duration | .122 | .055 | .053 | .036 |
| Cooperation | -.122–.203** | -.088–.196** | -.097–.191** | -.101–.157* |
| Industry | -.120–.007 | -.078–.069 | -.082–.064 | -.038–.047 |
| Revenue | -.068* | -.099 | -.114 | -.065 |
| **Relational Value** | | | | |
| $R^2$ | **.220**** | **.551**** | **.557**** | **.581**** |

*$^{+}$ $p \leq .10$; * $p \leq .05$; ** $p \leq .01$; IN: IT-enabled interfirm integration; CO: IT-enabled complementary capabilities; IS: IT-enabled information sharing; GO: IT-enabled governance.*

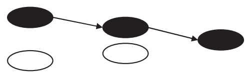
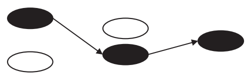
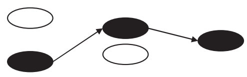
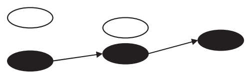
The primary criterion for assessing the PLS structural model is the explained variance of the endogenous variables, which typically depends on the research context (Hair et al. 2011). With an explained variance ranging between .334 and .583, these values lie at a satisfactory level compared to other studies on IT value co-creation. Furthermore, as shown in Table B-16, when solely considering the control variables, the explained variance lies at .220. This value significantly increases ($R^2$ = .551) when IT-enabled interfirm integration and IT-enabled complementary capabilities are added to the model, indicating the high relevance of this constructs as primary sources of relational value. However, we see a smaller increase in the explained variance when considering a direct relationship between IT-enabled information sharing and relational value (Model 3) or between IT-enabled governance and relational value (Model 4). This relatively weak increase in the explained variance is a first indication that the relationship between IT-related information-processing capabilities and relational value is fully mediated by digitally enabled interfirm capabilities in terms of both IT-enabled interfirm integration and IT-enabled complementary capabilities. In the following section, we analyze the mediation effects in greater detail.

### 1.6.3 Mediation analysis

The analysis of the direct path coefficients in the structural model reveals the significant direct influence of the information-processing capabilities on the digitally enabled capabilities and, in turn, their influence on relational value. This provides initial evidence for Hypotheses 5a–b and 6a–b. In a first step, we analyzed the effect sizes of the mediation and the significance of the indirect paths. We then tested for full and partial mediation. A precondition in PLS-based mediation analysis is high mediator reliability, as variance-based estimations tend to overestimate direct effects when indirect effects are included in the model. However, such unstable estimation can be avoided if the mediator is measured almost perfectly (Henseler 2012). Since both mediators – IT-enabled interfirm integration and IT-enabled complementary capabilities – display high construct reliability scores (individual item reliability > .84 and CR > .92), this should not be a major threat to our mediation analysis.

We computed indirect effects by multiplying the path coefficients of each single path, while inference statistics were computed using a bootstrapping resampling procedure. The results of the individual mediation paths reveal a significant effect for Hypotheses H5a, H5b, and H6a (see Table B-17).

*Table B-17. Significance of mediated paths*

| Indirect Effect | Hypothesis | Mediated Path | Graphical Representation | Path Coefficient | t-value |
|---|---|---|---|---|---|
| **IS → RV** | H5a | IS → IN → RV |  | .234 | 4.018** |
| | H5b | IS → CO → RV |  | .070 | 1.883+ |
| **GO → RV** | H6a | GO → IN → RV |  | .225 | 4.633** |
| | H6b | GO → CO → RV |  | .034 | 1.358 |

*+ $p \le .10$; * $p \le .05$; ** $p \le .01$; IN: IT-enabled interfirm integration; CO: IT-enabled complementary capabilities; IS: IT-enabled information sharing; GO: IT-enabled governance.*

To gain a deeper understanding of the mediation mechanisms that lead to relation value, we further compared fully and partially mediated models. Following the approach of Subramani (2004), we compared a full and a partial mediation model for each information-processing capability and assessed the increase in the explained variance through an additional path in the partial model. To do so, we computed both effect sizes [$(R^2_{\text{partial mediation}} - R^2_{\text{full mediation}})/(1 - R^2_{\text{partial mediation}})$] as well as the pseudo F statistic by multiplying $f^2$ with $(n - k - 1)$, whre $n$ is the sample size and $k$ the number of independent variables (Mathieson et al. 2001). The results of this nested model comparision are shown in Table B-18. In the case of IT-enabled governance, an additional direct path in the partially mediated model significantly ($p \leq .01$) increases the explanatory power ($f^2 = .069$), indicating the relevance of this additional path and leading to the conlusion that the influence of IT-enabled governance on relational value is partially mediated by IT-enabled interfirm integration but not by IT-enabled complementary capabilities. In contrast, when incorporating a direct path in the case of IT-enabled information sharing, the analysis reveals no significant effect on the explanatory power ($f^2 = .011$). Hence, our data indicates that the relationship between IT-enabled information sharing and relational value is fully mediated by both IT-enabled interfirm integration and IT-enabled complementary capabilities.

*Table B-18. Nested model comparison*

| Information Processing Capability | $R^2$ in Fully Mediated Model | $R^2$ in Partially Mediated Model | Effect Size ($f^2$) | Pseudo F |
|---|---|---|---|---|
| IS → RV | .551 | .556 | .011 | 1.588 |
| GO → RV | .551 | .580 | .069 | 9.736** |

*** $p \leq .01$; IS: IT-enabled information sharing; GO: IT-enabled governance.*

## 1.7 Discussion and Conclusion

### 1.7.1 Summary of findings

The results provide empirical support for the interpretation of digitally enabled interfirm capabilities as primary sources of relational value. Our results indicate that IOS can enable the exploitation and exploration of both interfirm integration (H1) and complementary capabilities (H2). Therefore, both capabilities play a critical role for partners in interfirm relationships, resulting in superior benefits, such as reduced costs, increased revenue, and improved processes and products. Moreover, we identified information-processing capabilities as antecedents of the digitally enabled capabilities. Both IT-enabled information sharing (H3a–b) and governance (H4a–b) provide and process information, which can be leveraged to develop higher-order digitalized capabilities.

We furthermore hypothesized that the relationship between the information-processing capabilities and relational value is mediated by the digitally enabled interfirm capabilities. The results of our study support this assumption for IT-enabled information sharing by showing a fully mediated relationship (H5a–b). Therefore, information exchange by the use of IOS is effective for enhancing relational value only by leveraging digitalized higher-order organizational capabilities. Partners in interfirm relationships therefore need to pass through the entire process of absorptive capacity to realize performance gains from shared information through IOS, especially including the exploitation of external information in digitalized higher-order capabilities. Regarding IT-enabled governance, the results are mixed. Although our results provide evidence that IT-enabled interfirm integration mediates the relationship between IT-enabled governance and relational value (H6a), we also found direct effects. One explanation can be derived from the relational view, where effective governance mechanisms are proposed as direct sources of relational value (Dyer and Singh 1998). A high level of IT-enabled governance might indicate that the partners in the relationship have generally developed effective governance mechanisms that reduce transaction costs and thus enable value creation. However, in order to realize the full potential of IT-enabled governance, the plans developed, control mechanisms established, and decisions made through the use of IOS must be leveraged and embedded in digitalized interfirm business activities. Another finding is that although IT-enabled governance facilitates IT-enabled complementary capabilities (H4b), evidence on a mediating relationship on relational value (H6b) is lacking. Hence, network partners in our sample probably do not leverage the additional level of IT-enabled complementary capabilities through IT-enabled governance to create relational value. In fact, the path coefficient between complementary capabilities and relational value is comparatively low (b = .163). This might be because regional networks are typically characterized by a high level of common understanding of their cooperation and mutual businesses (Sydow and Duschek 2011), reducing the need for using IOS to identify and exploit complementary capabilities among partners. Future research is needed to examine this issue in other types of relationships.

The empirical validation of our research model provides support for our reconceptualization and extension of the relational view. Relation-specific assets as direct sources of relational value must be rethought when applied to the special context of IS. Inter-organizational systems as relation-specific assets can be embedded in and enable all four sources of relational value. This led to the identification of the new construct of IT-enabled interfirm integration, which encompasses digitalized business activities as higher-order interfirm capabilities. We argue that this a significant change from investing in relation-specific assets, as the development of such capabilities requires different and more complex collaboration activities between partners in interfirm relationships (Barua et al. 2004; Rai et al. 2006). Furthermore, although IT-enabled complementary capabilities, information sharing, and governance have mechanisms that are related to the factors originating from the relational view, our results reveal a new configuration of the underlying logic. In the context of IS, only two sources lead directly to relational value: IT-enabled interfirm integration and complementary capabilities. To realize benefits from information-processing capabilities fully or even at all, higher-order digitalized capabilities must be developed. This could be demonstrated by the partially mediating effect of digitally enabled capabilities regarding IT-enabled governance and the fully mediating effect regarding information sharing. The underlying special characteristic of IS in this context is that the higher the order of IT-enabled capabilities is, the more immediate is their impact on business value (Pavlou and El Sawy 2006). Transferring these insights to our IT-related constructs, information processing capabilities enable the identification, assimilation, and transformation of information. However, the immediate impact on relational value is caused by the exploitation of information in terms of digitally enabled interfirm capabilities.

### 1.7.2 Theoretical and practical contributions

Our results provide two major theoretical contributions. First, by integrating all four IT-enabled sources of relational value into one nomological network, this study synergizes existing literature on IT-based value co-creation. The four constructs identified echo existing conceptualizations, but are more holistic and broaden the scope. Moreover, this study sheds light on the interdependencies between these factors and the hierarchy in the value co-creation process. So far, IOS literature has focused on a direct effect of IT-related information sharing (e.g., Lai et al. 2008; Liu and Ravichandran 2011; Rai et al. 2006; Wong et al. 2012) and governance (e.g., Im and Rai 2014; Rosenzweig 2009; Wei et al. 2013; Wong et al. 2015) on relational value or non-IT-related higher-order organizational capabilities. A mediating effect through digitally enabled capabilities has also not been investigated. This study thus takes a step toward filling the research gap regarding interdependencies between IT-enabled sources of relational value (Grover and Kohli 2012). Second, we provide a reconceptualization and extension of the relational view. While previous IS studies that borrowed the relational view as a reference theory (see Table B-12) provided valuable insights into value co-creation and progressed the research field, we aimed to go a step further. The proposed and empirically validated research model demonstrates how the nature of the constructs and the logic of the theory change when IT is embedded in the context. This can help us to understand relational value mechanisms in the special context of IS as well as to enrich and contribute to the reference theory itself (Grover and Lyytinen 2015). Furthermore, we lay a foundation for future research, either for going into greater detail or for the extension of our findings with additional constructs and mechanisms.

Our study also provides several recommendations for practitioners who aim to realize relational benefits from IT investments. The first recommendation is that managers should recognize digitally enabled capabilities as a central source of relational value. Relation-specific IT investments should therefore be evaluated according to their contribution to interfirm business activities, such as the optimization of supply chain processes or the development of digitalized products. Our results also offer suggestions for such management capabilities that foster the establishment of digitally enabled capabilities: Managers responsible for interfirm relationships should evaluate and jointly establish information-processing capabilities. However, as mentioned in the example of the bullwhip effect, it is crucial to establish routines and mechanisms to finally exploit this processed information in order to realize the anticipated benefits of information sharing and governance through IOS.

### 1.7.3 Limitations and directions for future research

One limitation of our research lies in the study design based on cross-sectional data with a single informant. Although the approach is widely applied in IT-based value co-creation research (e.g., Rai et al. 2006; Saraf et al. 2007; Wang et al. 2013) and our analysis indicated that common method bias is not an issue, a more powerful research design could validate and extend our findings. First, the use of secondary data and matched pair designs would enhance the robustness of our results and reduce the risk of differing perceptions of relationship partners. Second, collecting longitudinal data would provide insights into the dynamic processes and time shifting effects of relational value generation. Furthermore, the target population of regional networks in Germany might be considered as further limitation of this study. Regional networks are characterized by a high level of trust as well as long-term and stable relationships, providing favorable conditions for IT-based value co-creation (e.g., Klein and Rai 2009; Paulraj et al. 2008). Moreover, network partners tend to prefer regular face-to-face meetings, which is challenging in geographically distributed relationships (Provan and Kenis 2007). Therefore, our results might not be fully generalizable. Future research is necessary to transfer our findings to other types of interfirm relationships and international contexts in order to examine the role of partnership and contextual attributes.

Our study also lays the foundation for future research directions regarding the factors and mechanisms of IT-based value co-creation. Although we provided a generic framework that synergizes a broad range of existing research, future research should expand upon and investigate more deeply the IT-enabled sources of relational value and their interdependencies. For example, the relational view posits additional mechanisms that preserve relational value, such as asset interconnectedness and resource indivisibility (Dyer and Singh 1998), which could be applied to the IS context. Exploring further factors and their interdependencies by adapting other reference theories would strengthen our understanding of how value can be co-created through IT. Furthermore, we assumed that IT is embedded in the four sources of relational value. As the usefulness of different types of IS assets may differ across different business objectives (Aral and Weill 2007; Schryen 2013), it would be beneficial to examine the particular IOS in which firms invest to foster digitally enabled interfirm capabilities and information processing capabilities. Lastly, it would be promising to investigate how co-created value is distributed among partners and the extent to which spillover effects can be realized through the various IT-based sources of relational value.

## 1.8 Appendix

*Table B-19. Operationalization of the measurement scales*

| | | |
|---|---|---|
| **IT-enabled interfirm integration (IN)** | | |
| *IT enables your company within the inter-organizational network to…* | | |
| IN1 | Improve the efficiency of operation among partners. | Grover and Kohli 2012; Qrunfleh and Tarafdar 2014; Subramani 2004 |
| IN2 | Jointly develop new business opportunities. | |
| IN3 | Create new products, services, or enhancements. | |
| IN4 | Provide safeguards against opportunism through greater transparency of asset usage. | |
| **IT-enabled complementary capabilities (CO)** | | |
| *IT enables your company within the inter-organizational network to…* | | |
| CO1 | Identify complementary resources/capabilities among partners. | Grover and Kohli 2012 |
| CO2 | Exploit complementary resources/capabilities among partners. | |
| CO3 | Leverage complementary resources/capabilities among partners. | |
| **IT-enabled information sharing (IS)** | | |
| *IT enables your company within the inter-organizational network to…* | | |
| IS1 | Increase the level of information sharing. | Li and Lin 2006 |
| IS2 | Share information simultaneously across the partners. | |
| IS3 | Share proprietary information. | |
| IS4 | Share information accurately, reliably, and in a timely manner. | |
| **IT-enabled governance (GO)** | | |
| *IT enables your company within the inter-organizational network to…* | | |
| GO1 | Improve effectiveness of management decision making. | Chan et al. 2006; Sabherwal and Chan 2001 |
| GO2 | Facilitate strategic business planning. | |
| GO3 | Provide sufficiently detailed information to support prudent decision making. | |
| GO4 | Support detailed analysis of major business decisions. | |
| **Relational value (RV)** | | |
| *By working in an inter-organizational network, your company has received the following benefits over the last years:* | | |
| RV1 | Reduced operational cost for operations. | Im and Rai 2014 |
| RV2 | Increased revenue. | |
| RV3 | Improved service quality. | |
| RV4 | Faster order fulfillment. | |
| RV5 | Improvement in the launch of new products. | |

# 2 Study #4: The Role of Inter-Organizational IT Alignment for Co-Creating Value

*Table B-20. Fact sheet of Study #4*

| | |
|---|---|
| Title | The Role of Inter-Organizational IT Alignment for Co-Creating Value: Empirical Evidence from Regional Network Collaborations |
| Authors | Simon Thanh-Nam Trang, strang@uni-goettingen.de* <br> Markus Mandrella, mmandre@uni-goettingen.de* <br> Mauricio Marrone, mauricio.marrone@mq.edu.au** <br> Lutz M. Kolbe, lkolbe@uni-goettingen.de* <br><br> *Georg-August-Universität Göttingen, Chair of Information Management, Platz der Göttinger Sieben 5, 37073 Göttingen <br> **Macquarie University Sydney, Department of Accounting and Corporate Governance, Eastern Road, E4A, North Ryde NSW 2109 |
| Outlet | Journal of Information Technology (JIT), 1st revision, Completed Research Paper |
| Abstract | The majority of IT alignment research has primarily remained limited to intra-organizational alignment, leaving much to learn about the value creation potential of its largely neglected inter-organizational counterpart. Thus, the present study addresses this gap by investigating the role of inter-organizational IT alignment in co-creation of value among inter-organizational networks. We interpret inter-organizational IT alignment as a higher-order dynamic capability and integrate it in a nomological network comprised of three lower-order capabilities, i.e., IT infrastructure integration, information capabilities, and IT-enabled coordination, with relationship performance as the outcome variable. The hypotheses are tested with survey data (n = 241) from regional network collaborations in Germany. The results show that IT infrastructure integration, information capabilities, and IT-enabled coordination can significantly explain inter-organizational IT alignment. In turn, we also find that inter-organizational IT alignment significantly predicts relational performance for network partners. Findings further reveal that a significant amount of the variance shared between lower-order capabilities and relationship performance is mediated through inter-organizational IT alignment. Overall, inter-organizational IT alignment provides a mechanism for deriving value from inter-organizational IT resources. Given these findings, we conclude that the concept of IT alignment, which has been heavily examined in the intra-organizational context, should find more attention in the inter-organizational context. |
| Keywords | IT value co-creation; IT alignment; Inter-organizational networks |

## 2.1 Introduction

In highly competitive environments, organizations tend to focus on their core competencies while close collaboration with multiple partners becomes essential for coordinating and combining resources. Accordingly, the focus of traditional supply chain management on the strategic choice between 'make' or 'buy' has been extended by the dimension of long-term collaboration in inter-organizational networks (Sydow 1992). Studies report that these forms of multi-partner alliances, in comparison to classical dyadic alliances, make up 30 to 50 percent of all alliances (García-Canal et al. 2003; Heidl et al. 2014; Makino et al. 2007). Inter-organizational networks are composed of three or more organizations that are largely autonomous, geographically distributed, and heterogeneous regarding their operating environment, culture, and social capital (Camarinha-Matos and Afsarmanesh 2005). In network collaborations, organizations profit not only from the flexibility of resource integration, but also from complementary competences and the exchange of knowledge (Dyer and Singh 1998). They collaborate in coordinated economic activities to better achieve common or compatible goals that are repeatedly coordinated in time and space (Huxham and Vangen 2005). However, due to the difficulties of co-evolving with network partners and creating value from such relationships, cooperative networks suffer from a high failure rate (Lewin et al. 1999), often well in excess of 50 percent (Gulati et al. 2012). Information systems (IS) researchers, therefore, strive to understand how inter-organizational information technology (IT) resources can lead to co-created value to support inter-organizational relationships (Grover and Kohli 2012). Our research contributes to IT knowledge by addressing specific literature gaps in both IT-based value co-creation and inter-organizational IT alignment.

Research on IT-based value co-creation explores how multiple firms with different IT systems jointly create superior value (Grover and Kohli 2012). Studies often build on resource-based theoretical lenses when examining the phenomenon of value proposition through inter-organizational IT resources (Paulraj et al. 2008; Rai et al. 2006; Saraf et al. 2007). Prior research argues that inter-organizational networks must develop IT capabilities through synergistic combination with other resources and capabilities to address the specific challenges that arise within the network context (Grover and Kohli 2012; Rai et al. 2012). Recent studies identify various inter-organizational IT-related capabilities, such as IT integration (Chen et al. 2013; Saraf et al. 2007), information capabilities (Barua et al. 2004; Wong et al. 2012), and IT-enabled coordination (Im and Rai 2014; Nicolaou et al. 2011). Yet, in spite of the considerable efforts and findings in this research field, advanced knowledge on IT capability development for co-creating value remains limited. This is reflected by inconsistent research findings, i.e., direct vs. indirect effects (e.g., Dong et al. 2009; Rai et al. 2006) as well as some insignificant relationships (e.g., Saldanha et al. 2013) between inter-organizational IT capabilities and co-created value. Therefore, we identify an area of research opportunity for developing a deeper understanding of the mechanisms driving IT-based value co-creation (Grover and Kohli 2012).

The concept of IT alignment refers to the general fit between IT and business components (Luftman and Brier 1999), and is considered an important source of IT business value among the most focal topics of management concern over recent years (Luftman 2016). A multitude of studies has extended our understanding of the antecedents, consequences, conceptualization, and operationalization of IT alignment, providing ample emprical support for its role as a key driver of organizational performance (Gerow et al. 2014; Luftman et al. 2017). However, IT alignment is rarely investigated from the inter-organizational perspective outside of its conceptualization (e.g., Katzy et al. 2016; Zarvić et al. 2012) and influence on supply chains performance (e.g., Sanders 2005; Wu et al. 2006), and has yet to fully explore its potential for transforming IT resources to meet inter-organizational relationship requirements (Coltman et al. 2015; Katzy et al. 2016). To the best of our knowledge, there is no study which theoretically derives causal explanations regarding the role of IT alignment in the inter-organizational IT capability building process for value co-creation.

Based on these two research gaps in the largely independent research fields of IT-based value co-creation and inter-organizational IT alignment, the aim of this study is to integrate the concept of IT alignment into research on inter-organizational IT capabilities. The motivation for this research stems from two core observations from relevant literature: First, the concept of IT alignment as a driver for organizational performance is well-established and finds empirical support in individual firms (Gerow et al. 2014; Luftman et al. 2017), which provides a solid conceptual starting point for analysis of IT-based value co-creation mechanisms. Hence, we expect that IT alignment can enrich our understanding of joint creation of superior value by leveraging common IT resources (Coltman et al. 2015). Second, typical characteristics of inter-organizational networks, such as a lack of information integration among partners, instability in alliances, and a lack of hierarchical decision-making (Winkler 2006) differentiate inter-organizational IT alignment from the intra-organizational context and further emphasize IT alignment challenges (Coltman et al. 2015; King 2013). In summary, there is both a potential and a need for examing IT alignment in inter-organizational contexts. We therefore aim to answer the following research question: What is the role of inter-organizational IT alignment for co-creating value?

The research question is addressed through empirical validation of a theoretically derived research model. Drawing on dynamic capability theory (Eisenhardt and Martin 2000; Teece et al. 1997), we interpret inter-organizational IT alignment as a dynamic capability and as an immediate source of outcomes realized by network members. In particular, we examine outcomes that directly result from collaboration in inter-organizational networks, i.e., relationship performance (Klein and Rai 2009). We conceptualize alignment as the fit between inter-organizational business and IT infrastructures and processes, reflecting a focus on performance enhancement through inter-organizational IT capabilities (Henderson and Venkatraman 1993; Katzy et al. 2016). We identify three lower-order capabilities – IT infrastructure integration, information capabilities, and IT-enabled coordination – based on the distinction between lower- and higher-order capabilities in the IS literature (Barua et al. 2004; Pavlou and El Sawy 2006; Rai et al. 2006). These capabilities can be leveraged to develop inter-organizational IT alignment. A questionnaire-based survey in the context of organizations in regional networks in Germany is conducted to validate the research model. Regional networks are characterized by their common agglomeration area and serve as a relevant unit of analysis for examining inter-organizational IT alignment. Regional networks are typically characterized by equal decision-making across companies, in contrast to highly hierarchical and strategic network types like supply chains, where decisions are made by one or a few central companies (Sydow and Duschek 2011). This differentiates inter-organizational IT alignment from less complex firm-level contexts (Katzy et al. 2016). Moreover, regional networks are characterized by long-term orientation and trust when compared to their more dynamic counterparts such as smart business networks (Collins et al. 2010), implying a need for advanced and joint IT capability development.

This study contributes to two major IS research streams. First, we extend existing research on IT-based value co-creation by interpreting inter-organizational IT alignment as a higher-order dynamic capability and an important explanatory factor in the relationship between inter-organizational IT capabilities and performance outcomes. Therefore, we contribute to clarification of conceptual inconsistencies in previous research by explaining this relationship within a theory-based conceptual framework. Second, our analysis contributes to IT alignment literature by surpassing the conceptualization of IT alignment beyond the firm-level source of value to the inter-organizational level. Consequently, we stress the importance of IT alignment in inter-organizational networks and identify specific characteristics of achieving and creating value through IT alignment in this context.

The remainder of the paper is organized as follows: In the next section, we proceed by exploring prior work that has addressed IT capabilities in the context of inter-organizational collaboration, followed by an explanation of dynamic capabilities and inter-organizational IT alignment. Next, we develop the research model and hypotheses for our research. The subsequent sections present the design of the research study and the empirical results. We follow this with a description of the research findings and a discussion of their theoretical and managerial implications, concluding with limitations regarding the interpretations of our results and directions for future research.

## 2.2 Theoretical Background

### 2.2.1 Inter-organizational IT capabilities

Following the theoretical perspective of the resource-based view (RBV) in IS research, it is argued that IT-related resources such as technological assets or human resources typically do not meet the RBV-related criteria of heterogeneity and immobility (Nevo et al. 2007; Santhanam and Hartono 2003; Wade and Hulland 2004). Competitors can easily replicate investments in IT resources by purchasing the same software and hardware, as they are widely available on the market and mobile in nature (Powell and Dent-Micallef 1997). Therefore, the core value of IT resources is derived from its synergistic combination with other IT- and non-IT-related resources rather than the IT investments themselves. The capability to apply such IT resources efficiently and effectively is regarded as the key to competitive performance (Mata et al. 1995; Wade and Hulland 2004). Following this perspective, an IT capability can be defined as “the ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities” (Bharadwaj 2000, p. 171).

According to Wade and Hulland (2004), IT capabilities can be classified into three types: (1) inside-out capabilities are developed from inside the firm in response to requirements of the market; (2) outside-in capabilities are externally oriented and focus on managing external relationships and resources; and (3) spanning IT capabilities integrate inside-out and outside-in IT capabilities by involving both an external and internal perspective. Since this three-dimensional framework of IT capabilities is predominantly conceptualized at the firm level, we customize the framework in the context of inter-organizational networks (Dong et al. 2009), identifying three IT capabilities within previous literature on inter-organizational IT capabilities (see Table B-21), including: (1) IT infrastructure integration, (2) information capabilities, and (3) IT-enabled coordination. Below we discuss their definition, fit within the framework, and importance for inter-organizational networks.

IT infrastructure integration is defined as "the extent to which the IS applications of a focal firm work as a functional whole in conjunction with the IS applications of its business partners" (Saraf et al. 2007, p. 324). It requires internal technological skills and is developed from inside the firm, thus representing an inside-out IT capability (Dong et al. 2009). An integrated IT infrastructure connects different databases and applications of network partners by establishing communication platforms and common data standards and is being regarded as the "nerve system" of interfirm collaboration (Dong et al. 2009; Prasad et al. 2013). Accordingly, IT infrastructure integration has been identified as an important capability in inter-organizational relationships. For example, Rai et al. (2006) find that IS integration between supply chain partners has a positive impact on higher-order supply chain capabilities.

Information capabilities refer to the abilities of a firm to exchange tactical and strategic information with network partners based on IS applications (Barua et al. 2004). Information capabilities represent outside-in capabilities because they strengthen inter-organizational flow of knowledge and aim to recognize valuable information from network partners (Roberts and Grover 2012). Due to the critical importance of information sharing to inter-organizational network functionality and subsequent reduction of uncertainty, its support through information systems is being regarded as substantial inter-organizational IT capability (Wong et al. 2012). Consequently, beneficial outcomes resulting from information capabilities have enjoyed much attention from research studies (e.g., Barua et al. 2004; Malhotra et al. 2005; Wong et al. 2012).

IT-enabled coordination refers to the extent to which IT is used for planning and arranging the interdependent activities in which network partners collectively engage (Nicolaou et al. 2011). This includes, for example, interpretation support systems for effective decision-making (Malhotra et al. 2005) and IS for collaborative planning (Wang et al. 2013). Such systems provide the basis to manipulate, assimilate, and blend internal and external information of a firm collaborating in an inter-organizational network, thus representing a spanning IT capability (Roberts et al. 2012). IT-enabled coordination facilitates management of complex interdependencies between networked organizations, and is recognized as important inter-organizational IT capability (Im and Rai 2014; Nicolaou et al. 2011).

*Table B-21. Illustrative quantitative studies investigating the effect of inter-organizational IT capabilities on performance outcomes*

| Study | Inter-organizational IT Capabilities | | | Impact on Performance | Statistical significance of relationships |
|---|---|---|---|---|---|
| | Inside-out | Outside-in | Spanning | | |
| Truman (2000) | Interface Integration | | | Direct | Interface Integration → Performance Outcomes (x) |
| Barua et al. (2004) | Systems integration | Online Information Capabilities | | Indirect | Systems integration → Online Information Capabilities (*) → Digitization Level (*) → Financial performance (o) |
| Zhu and Kraemer (2005) | Backend Integration | | | Direct | Backend integration → E-Business Value (*) |
| Rai et al. (2006) | IT infrastructure integration | | | Indirect | IT infrastructure integration → Supply Chain Process Integration (*) → Firm Performance (*) |
| Saraf et al. (2007) | IS integration | | | Indirect | IS integration → Knowledge sharing (*) → Performance (o)<br>IS integration → Process Coupling (*) → Performance (o) |
| Dong et al. (2009) | Backend integration | Partner support | Managerial skills | Direct | Backend integration → Supply chain process performance (*)<br>Partner support → Supply chain process performance (*)<br>Managerial skills → Supply chain process performance (*) |
| Nicolaou et al. (2011) | | | Information coordination use, Information control use | Indirect | Information coordination use → Trust (*) → Performance (*)<br>Information control use → Trust (negative*) → Performance (*) |
| Wong et al. (2012) | | Information integration | | Direct | Information Integration → Business Performance in SCM (*) |
| Chen et al. (2013) | IT integration | | | Indirect | IT integration → Hospital-supplier integration (*) → Supply Chain Performance (*) |
| Saldanha et al. (2013) | | IT for information partnering | | Direct | IT for information partnering → Performance (x) |
| Wang et al. (2013) | | | IT-enabled Planning and Control | Direct and Indirect | IT-Enabled Planning and Control → Buyer's Manufacturing Goals Achievement (*)<br>IT-Enabled Planning and Control → Supplier's Relation-Specific Business Process Investments (*) → Buyer's Manufacturing Goals Achievement (*) |
| Im and Rai (2014) | | | Use of interpretation support systems | Indirect | Use of interpretation support systems → IOR contextual ambidexterity (*) → Relationship performance & quality (*) |
| Wong et al. (2015) | | Inter-organizational information integration | IT-enabled collaborative decision-making | Indirect | Inter-organizational information integration → IT-enabled collaborative decision-making (*) → Customer service performance (*) |

*Note: (*) significant relationship, (x) insignificant relationship, (o) partially significant relationship (e.g., analysis of different samples)*

However, research findings regarding the relationships between inter-organizational IT capabilities and performance outcomes demonstrate inconsistencies. First, while some studies assume direct impacts (e.g., Wong et al. 2012; Zhu and Kraemer 2005), other studies postulate indirect relationships through intermediate factors (e.g., Rai et al. 2006; Wong et al. 2015). Second, while most studies find either positive or positive mediated relationships between inter-organizational IT capabilities and performance, some reveal insignificant relationships (e.g., Saldanha et al. 2013; Saraf et al. 2007). Both inconsistencies result in limited understanding of how inter-organizational IT capabilities lead to value in inter-organizational networks, calling for deeper understanding of the mechanisms of IT-based value co-creation through further research (Grover and Kohli 2012). Importantly, studies exploring IT capabilities have indicated that higher-order capabilities such as supply chain integration (Rai et al. 2006) and contextual ambidexterity (Im and Rai 2014) can explain how these capabilities enhance performance. We argue that inter-organizational IT alignment as a higher-order capability can be a further explanatory factor in this value co-creation process and may help to clarify prior inconsistencies in the literature.

### 2.2.2 Dynamic capabilities and inter-organizational IT alignment

Dynamic capability theory is an extension of the RBV and defines dynamic capabilities as "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997, p. 516). New opportunities and threats from environmental changes must be scanned continuously, and organizational resources and capabilities must be renewed accordingly in order to differentiate or remain unique and difficult to imitate, thus helping to sustain competitive advantage (Eisenhardt and Martin 2000; Teece 2007). Dynamic capability theory has been adapted by IS researchers to investigate the mediating effect of IT capabilities on co-created value. For example, sustainable commitment from top management (Prasad et al. 2012), learning capability (Wu 2006), and the use of IT to implement new business processes (Drnevich and Kriauciunas 2011) have been identified as dynamic capabilities that lead to performance benefits. In this context, dynamic capabilities have also been conceptionalized as higher-order capabilities shaped by lower-order IT capabilities (Liu et al. 2013). Although IT capabilities can generally lead to business value, firms need to ensure that they will respond positively to environmental changes when developing these capabilities in order to achieve and maintain a competitive advantage through IT investments (Wade and Hulland 2004).

IT alignment has been identified as a dynamic capability in existing literature (Chen et al. 2008; Leonard and Seddon 2012; Schwarz et al. 2010), described as “applying IT in an appropriate and timely way and in harmony with business strategies, goals, and needs” (Luftman and Brier 1999, p. 109). By facilitating efficient and effective use of information systems, IT alignment can help firms to achieve competitive advantage and react quickly to changes in the environment (Avison et al. 2004). Thus, IT alignment can be regarded as a firm’s capability to align IT- and business-related resources to achieve competitive advantage (Schwarz et al. 2010). The Strategic Alignment Model (SAM) by Henderson and Venkatraman (1993) is a widely accepted and often cited model in IS research (Chan and Reich 2007; Gerow et al. 2015) classifying information systems into four business and IT components, i.e., business strategy, IT strategy, organizational infrastructure and processes, and IS infrastructure and processes. Accordingly, IT alignment is defined as the fit between two or more of these components to ensure that business and IT remain in harmony (Chan and Reich 2007; Luftman and Brier 1999). The conceptualization of alignment as the fit between these components is consistent with the dynamic capability view of alignment. Henderson and Venkatraman (1993, p. 473) already emphasize that IT alignment as strategic fit is “not an event but a process of continuous adaptation and change”. Since then, scholars have adopted the view of IT alignment as a “moving target” (Avison et al. 2004) where organizations intend to realize alignment through a continuous process of linking business and IT strategies, processes, and infrastructures (Baker et al. 2011; Chen et al. 2008; Gerow et al. 2015). Therefore, the entire process of alignment can be conceptualized as a dynamic capability that results in an improved fit between business and IT (Chen et al. 2008; Luftman et al. 2017; Schwarz et al. 2010).

Thus far, while some conceptual research on inter-organizational IT aligment exists (e.g., Katzy et al. 2016; Mandal et al. 2003; Zarvić et al. 2012), the topic has received limited overall attention. For example, Katzy et al. (2016) extend the Strategic Alignment Model to inter-organizational networks through analyzing a European automotive network. Furthermore, IT alignment has been subject to investigations in the context of supply chains (e.g., Sanders 2005; Seggie et al. 2006; Wu et al. 2006). For example, Wu et al. (2006) show that IT alignment across the supply chain leads to advanced supply chain capabilities which in turn enhance market and financial performance. However, dominant firms in the supply chain can impose strategies and information systems on the other companies, differentiating the context from inter-organizational networks (Katzy et al. 2016). Moreover, these studies do not examine the role of IT alignment with regard to other inter-organizational IT capabilities.

Inter-organizational IT alignment involves multiple firms, leading to additional alignment levels and interdependencies due to heterogeneity of structures, processes, systems, and even alignment capabilities within the member organizations (Coltman et al. 2015; Zarvić et al. 2012). Moreover, issues about accountabilities, resource allocations, and interoperability of systems require collaboration between independent firms and therefore different actions to achieve alignment (Katzy et al. 2016; Provan and Kenis 2007). Drawing from the conceptualization of IT alignment in inter-organizational networks by Katzy et al. (2016), we analyze network-level alignment between business and IT infrastructures and processes. While the IT component encompasses IT architectures and applications for networked firms (e.g., common IT platforms, cloud applications, and inter-organizational systems) and supportive processes (e.g., customer service or scheduling), the business component comprises inter-organizational business processes and structures such customer order or network management processes (Gerow et al. 2016; Katzy et al. 2016; Riemer and Klein 2006). Our conceptualization therefore corresponds with the perspective of "functional integration" of SAM (Henderson and Venkatraman 1993), which has also been labeled "internal" (Chan and Reich 2007), "operational" (Gerow et al. 2015) or "process-level" (Queiroz 2017) alignment, and has further been examined as a firm-level performance factor. The concept of inter-organizational alignment should be distinguished from integration or "accordance" (Katzy et al. 2016), which refers to the correspondence of infrastructures and processes of network members with network-level systems and infrastructures.

The conceptualization of IT alignment as the fit between inter-organizational business and IT infrastructures is suited for the context of our study for several key reasons: First, we view alignment as a capability and aim to further investigate its role in the value co-creation process with other inter-organizational IT capabilities. We therefore argue that utilizing a tangible fit-related conceptualization of alignment is more consistent with our theory than intangible alignment concepts, such as social alignment (Gerow et al. 2016; Wagner et al. 2014). Second, in contrast to single firms or market relationships, inter-organizational networks lack hierarchy and control, which often leads to informal, emergent, and implicit strategies (Sturm et al. 2004). In addition to resulting difficulties in conceptualization and measurement, strategic alignment in inter-organizational networks may not always exist or serve as a desirable or effective solution (Katzy et al. 2016). Lastly, as changes in IT first impact business at the process level (Ray et al. 2005; Tallon 2007), we argue that analyzing alignment at the infrastructure and process level best reflects the dynamic capability to respond to environmental changes.

### 2.3 Research Model

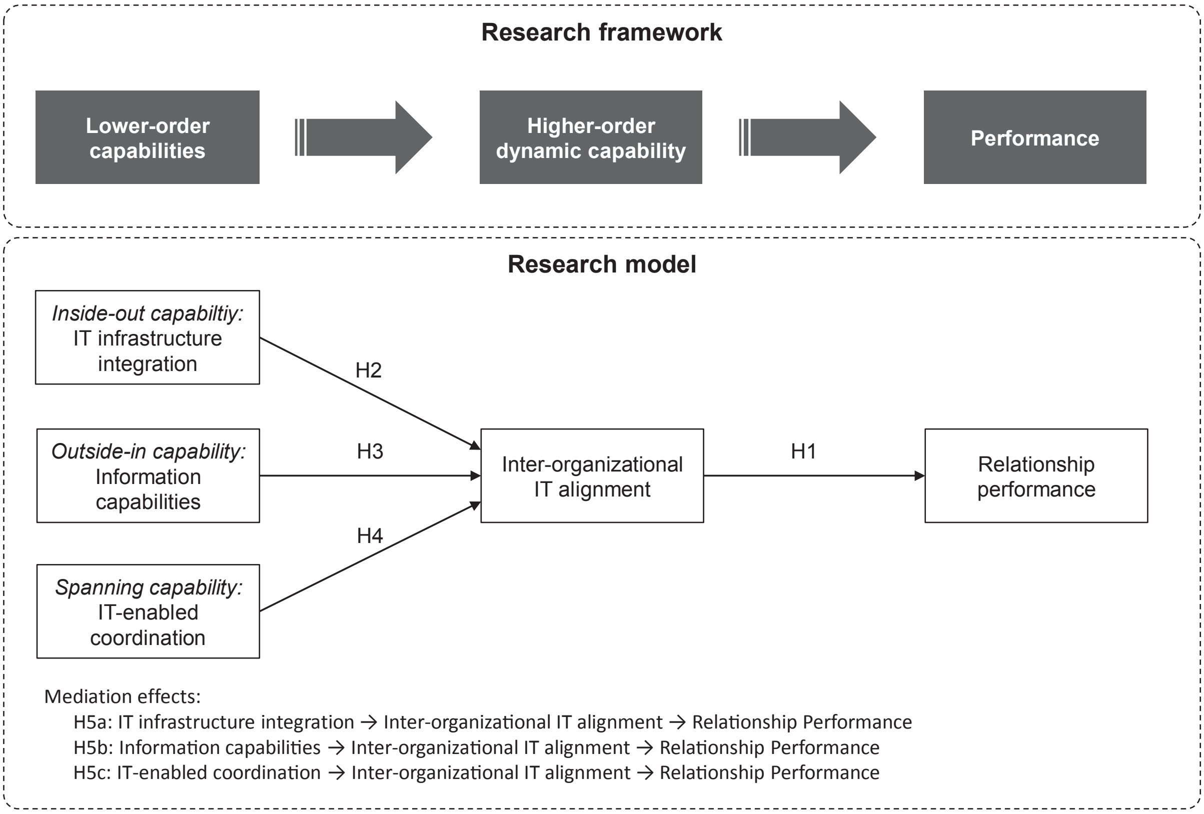



*Figure B-5. Research framework and research model*

We seek to understand the role of inter-organizational IT alignment in co-creating value. To answer our research question, we present the framework and research model of our study in Figure B-5, drawing on dynamic capability theory and distinction between higher- and lower-order capabilities in IS research (Rai et al. 2006). First, we interpret inter-organizational IT alignment as a dynamic capability and therefore as an immediate source of relationship performance. Second, this study conceptualizes IT infrastructure integration, information capabilities, and IT-enabled coordination as lower-order capabilities that can be leveraged to develop the higher-order capability of inter-organizational IT alignment, in turn leading directly to relationship performance. According to the distinction between higher- and lower-order capabilities, the higher the order of capabilities, the more direct the impact on performance outcomes (Pavlou and El Sawy 2006; Rai et al. 2006). Following this logic, we propose IT infrastructure integration, information capabilities, and IT-enabled coordination as the basis for inter-organizational IT alignment, being farther away from relationship performance. Therefore, we hypothesize that inter-organizational IT alignment mediates the relationships between the lower-order capabilities and relationship performance. We focus on the role of inter-organizational IT alignment in co-creating value and propose a hierarchy of lower- and higher-order capabilities. Therefore, direct effects between the lower-order capabilities and with relationship performance are not specified.

### 2.3.1 Inter-organizational IT alignment as a source of relationship performance

In our research model, we identify relationship performance as the outcome variable. Research on IT business value assesses IT impacts at the specific domain of interest where immediate effects are expected (Klein and Rai 2009; Ray et al. 2005). In the context of our study, we aim to examine superior benefits resulting from collaboration in inter-organizational networks. Considering that relationship performance measures the benefits realized by each network partner that are attributable to cooperating in the network relationship, we integrate it in our research model as appropriate outcome variable (Klein and Rai 2009). Consistent with previous research, we consider both tangible economic outcomes, i.e., reduced operational costs, increased revenue, and productivity, as well as intangible dimensions, i.e., increased flexibility, improved launch of new products and services, and better service quality (Im and Rai 2014; Klein and Rai 2009).

In accordance with research on intra-organizational IT alignment, we interpret inter-organizational IT alignment as a dynamic capability leading to superior performance outcomes for network partners. Although inter-organizational IT resources, such as collaborative platforms or supply chain systems, can be beneficial for network partners (Chi and Holsapple 2005; Sambamurthy et al. 2003), these IT resources are widely available on the market and can easily be replicated by competitors (Barua et al. 2004; Mata et al. 1995). To achieve and maintain a competitive advantage, partners in inter-organizational networks must align their IT resources with business infrastructures and processes in response to environmental changes. Inter-organizational IT alignment is the dynamic capability to ensure a fit between inter-organizational IT and business infrastructures and processes, resulting in increased effectiveness and efficient use of collaborative IT resources. This strengthens the financial position of network partners while reducing its operational costs (Sanders 2005). Moreover, such a capability is unique to the network and therefore difficult for competitors to imitate, thus strengthening the competitive and market position of network partners (Dyer and Singh 1998; Sambamurthy et al. 2003). These arguments are supported by studies that have emphasized the important role of IT alignment in inter-organizational networks (e.g., Katzy et al.

2016; Zarvić et al. 2012) and revealed its performance-enhancing impact in supply chains chains (e.g., Sanders 2005; Seggie et al. 2006; Wu et al. 2006). Therefore, we propose the following hypothesis:

**Hypothesis 1 ($H_1$):** Inter-organizational IT alignment positively impacts relationship performance.

### 2.3.2 Antecedents of inter-organizational IT alignment

Based on the distinction between lower- and higher-order capabilities, we specify IT infrastructure integration, information capabilities, and IT-enabled coordination as antecedents of inter-organizational IT alignment. Individual hypotheses are developed in the following.

#### 2.3.2.1 IT infrastructure integration

An integrated IT infrastructure acts as an enabler for inter-organizational IT alignment (Katzy et al. 2016). Only when a certain degree of IT integration between network partners exists can inter-organizational systems (IOS) be integrated into inter-organizational processes and infrastructures (Dong et al. 2009; Saraf et al. 2007). For example, adaptations in supply chain processes, such as inventory stock levels, transportation routes, and production plans, are facilitated by smooth information flows and seamless data access through integrated information systems (Bharadwaj et al. 2007). This integration of IS into inter-organizational processes and structures enables the development of higher-order capabilities (Rai et al. 2006), such as IT alignment. Furthermore, IT integration can be seen as a relation-specific investment (Chen et al. 2013), which increases the willingness of network partners to engage in further value-adding initiatives (Saraf et al. 2007), such as IT alignment. This applies particularly to IT integration because it is customized and specific to the network (Saraf et al. 2007). IT infrastructure integration has been thorouhgly researched as an important antecedent to inter-organizational higher-order capabilities, such as supply chain capabilities (Rajaguru and Matanda 2013) and supply chain integration (Chen et al. 2013; Rai et al. 2006). This might indicate that IT infrastructure integration also has a positive impact on the higher-order capability of inter-organizational IT alignment. We, therefore, propose our second hypothesis below:

**Hypothesis 2 ($H_2$):** IT infrastructure integration positively impacts IT inter-organizational IT alignment.

#### 2.3.2.2 Information capabilities

To successfully align inter-organizational processes and information systems, network partners require knowledge about each other's processes and IT systems and their interdependencies (Zarvić et al. 2011). IT-enabled exchange of information provides the resources for facilitating the transfer of higher value–adding and rich information sharing (Malhotra et al. 2005). The increased level and higher quality of information exchange provide inter-organizational networks with the conditions needed for developing higher-order capabilities (Malhotra et al. 2005), including inter-organizational IT alignment. Therefore, network members can more efficiently refine and synchronize processes and structures (Im and Rai 2008) and improve resource allocations (Klein and Rai 2009) in order to achieve inter-organizational IT alignment. Furthermore, information capabilities increase transparency between network partners, thus reducing uncertainty and opportunistic behavior (Chi and Holsapple 2005) while enhancing the willingness to develop joint capabilities like inter-organizational IT alignment. These arguments are supported by various studies that investigate the effect of information capabilities on higher-order inter-organizational factors, such as the digitization level (Barua et al. 2004) and supply chain flexibility (Wang et al. 2015). Taking these findings into account, it can be argued that information capabilities also facilitate the inter-organizational capability of IT alignment. We therefore propose a third hypothesis:

**Hypothesis 3 ($H_3$):** Information capabilities positively impact inter-organizational IT alignment.

#### 2.3.2.3 IT-enabled coordination

Coordination has been recognized as critical in the context of inter-organizational networks (Provan and Kenis 2007). IT-enabled coordination between network partners is carried out by identifying, processing, and analyzing huge amounts of data, leading to improved planning and decision-making (Im and Rai 2014; Wang et al. 2013). Thereby, IT-enabled coordination contributes to developing an effective and efficient use for common resources in an inter-organizational network, finding synergies between network partners, and solving complex problems (Provan and Kenis 2007; Wang et al. 2013). Effective and efficient decisions ensure that network partners invest in the appropriate information systems and infrastructures to support inter-organizational processes and structures (Hadaya and Cassivi 2012). Moreover, when managing inter-organizational resources and activities, opportunistic behavior can occur because of conflicts and distrust between network partners. In this context, self-enforcing safeguards serve as cost-effective and practical preventative means (Chi and Holsapple 2005; Dyer and Singh 1998). The capability of IT-enabled coordination can be regarded as safeguard, leading to less opportunistic behavior of partners in inter-organizational networks (Grover and Kohli 2012; Wang et al. 2013). In addition to the resulting shared responsibility and accountability, this enhances the willingness and motivation of network partners to engage in value-adding initiatives (Dyer and Singh 1998; Prasad et al. 2013), such as IT alignment. Therefore, we propose the fourth hypothesis:

**Hypothesis 4 ($H_4$):** IT-enabled coordination positively impacts inter-organizational IT alignment.

#### 2.3.3 The mediating role of inter-organizational IT alignment

We now propose that, moreover, the relationship between inter-organizational IT capabilities and relationship performance is mediated by inter-organizational IT alignment. Although some previous studies found a direct impact of IT infrastructure integration (e.g., Dong et al. 2009), information capabilities (e.g., Wong et al. 2012), and IT-enabled coordination (e.g., Wang et al. 2013), we argue that a performance generating effect results from encouraging the alignment of inter-organizational business and IT components.

In particular, simply putting in place an integrated IT infrastructure may not be necessarily beneficial for network partners (Bharadwaj et al. 2007). For example, a tightly integrated system with a high level of standardization and common data standards could potentially benefit networks like logistic networks with clearly defined business processes and member roles but may not be appropriate in relationships with loosely coupled members. Such an integrated system would hinder and disrupt the operational processes in the network, which would reflect a misalignment. In contrast, a more loosely coupled infrastructure that technically integrates the network partners, by for instance integrating commodity modules, would be appropriate in this context (Katzy et al. 2016). Therefore, we argue that in order to generate value, network members must ensure the fit of integrated IT to network infrastructure and processes, describing a mediation hypothesis:

**Hypothesis 5a ($H_{5a}$):** Inter-organizational IT alignment mediates the relationship between IT infrastructure integration and relationship performance.

Electronically shared information per se does not offer much value (Kim et al. 2006). Instead, information capabilities unfold their full value when shared information between network members is actually exploited in common business processes (Malhotra et al. 2005). For example, improved information flow enabled by IT can be embedded in optimized supply chain processes to reduce the bullwhip effect (Lee et al. 2014). Accordingly, superior performance outcomes for inter-organizational networks such as lower operation costs and improved serviced quality are ultimately realized when shared information is used to refine and optimize inter-organizational business processes. Inter-organizational IT alignment ensures that IT systems for information sharing are appropriate regarding their support of networked business processes and infrastructures, and therefore facilitates network-wide sharing of information that is needed and used for common business processes and activities. We therefore propose a fifth hypothesis:

**Hypothesis 5b ($H_{5b}$):** Inter-organizational IT alignment mediates the relationship between information capabilities and relationship performance.

Although IT-enabled coordination can lead to improved planning and decision-making in inter-organizational networks, members of the network may still be unable to fully benefit from IT-enabled coordination when the coordination mechanisms are not performed correctly (Wang et al. 2013). Any plans developed or decisions made through the application of IS must finally be implemented and well-aligned with inter-organizational business processes and activities (Wang et al. 2013). Moreover, to achieve superior performance, the quality of coordination mechanisms must be evaluated and ensured (Wu et al. 2015). Hence, we argue that IT-enabled coordination does not directly impact relationship performance without first enabling network partners to successfully align their IT and business infrastructures and processes. We therefore propose a final hypothesis:

**Hypothesis 5c ($H_{5c}$):** Inter-organizational IT alignment mediates the relationship between IT-enabled coordination and relationship performance.

#### 2.3.4 Controls

In order to improve methodological rigor, we specified several control variables for inter-organizational IT alignment and relational value, including firm size, industry, IT investment, area of cooperation, network duration, network size, and environmental turbulence. The selection of these control variables was reasoned through the following process: First, it has been empirically shown that IT usage can differ greatly between firms of different sizes, industries, areas of cooperation, and network sizes and might, thereby, influence alignment necessity and performance gains through IT (Das and Teng 2000; Gerow et al. 2014; Hitt et al. 2002). Second, there is evidence supporting the influence of network size on governance effectiveness (Provan and Kenis 2007) and communication structure (Schilling and Phelps 2007). Third, the degree of environmental turbulence can determine both the possibility and necessity of alignment (Tallon and Pinsonneault 2011). Through the lens of IT alignment as a dynamic capability, environmental turbulence also points to the ability of permanent realignment with changing conditions. Thus, we also use these variables as controls for alignment and performance gains. Moreover, environmental turbulence is added as a moderator between inter-organizational IT alignment and relationship performance.

## 2.4 Research Design

A cross-sectional survey was conducted on 241 organizations across Germany, collecting regional network collaboration data across inter-organizational networks with standardized questionnaires. We chose organizations within regional networks as the unit of analysis. To be specific, the research design examines the capability of a single organization to align IT resources with relationships to other organizations in the same regional network cluster. Regional networks are defined as a set of organizations that collaborate for common goals. These networks are characterized by their local proximity and common social milieu in terms of a similar understanding of cooperation, communication, and conflict resolution (Sydow and Duschek 2011). The nature of collaboration lies in an extensive exchange of not only tangible assets, but also intangible assets such as information and knowledge. Typical objectives for networks lie in common product development activities (e.g., in optical industry clusters), common marketing activities (e.g., broker networks), or industry networks for resource sharing (e.g., industrial symbiosis). Collaborations in regional clusters often involve different forms of cooperation. For example, in an optical laser network, each organization provides a specialized resource to the network, such as lenses, transformers, or microelectronics. The area of cooperation for such a network lies in research/development, production, and sales.

Regional networks are particularly suitable for two reasons. First, this network type is often based on long-term reoccurring collaborations and personal, high-trust relationships (Provan and Kenis 2007). Stability of relationships allows for development and maintenance of advanced and joint IT resources and capabilities. Networked organizations such as optical laser clusters rely on a variety of integrated IT solutions for their research, development, and operations activities. Typical IT in this area include shared databases (e.g., shared patent databases, continual improvement or innovation databases), integrated collaborative software for the exchange of semi-structured data (e.g., calendar and scheduling systems, controlled- access wikis, or secure file sharing for product development), or integrated process solution (e.g., CAD systems for product design, workflow systems for test management, or quality management). Second, regional networks can have many different forms and characteristics in terms of, for example, their industry and governance forms (Provan and Kenis 2007). This variation allows for better generalizability of the empirical findings. In contrast to other types of networks that are more hierarchically and strategically oriented, decision-making in regional networks has a stronger emphasis on negotiation (Sydow and Duschek 2011). Aligning business and IT in this context is more complex and different from the firm-level (Katzy et al. 2016). Both aspects show us that organizations in regional networks represent an appropriate sampling frame for this study.

#### 2.4.1 Measures

The survey instrument was developed based on a comprehensive review of appropriate measurement scales for each theoretical construct. All scales were adapted from prior literature, and the items were selected based on their consistency with the construct definition in this research, measurement quality, and application in other studies. To adjust the scales to the research context of this investigation, the items have been carefully reworded. The latent measurement scales, including construct definitions, items, and sources are summarized in the Appendix (see Table B-26).

Relationship performance is measured on a 5-item reflective scale as implemented in Klein and Rai (2009) and Im and Rai (2014). For inter-organizational IT alignment, a reflective scale from Gerow et al. (2015) was revised, resulting in 6 items that are consistent with the definition inter-organizational IT alignment in this investigation. Accordingly, the items reflect the dynamic capability of inter-organizational IT alignment which results in an improved fit between inter-organizational IT and business infrastructures and processes (Gerow et al. 2015). IT infrastructure integration was adapted from Saraf et al. (2007) and covers a reflective 5-item scale, while information capabilities was measured with a 5-item scale adapted from Wong et al. (2012), and IT-enabled coordination by a 5-item scale by Nicolaou et al. (2011).

Aside from environmental turbulence, all controls were measured by a single item scale. Environmental turbulence was adapted from Wang et al. (2012) with a 4-item scale. On an ordinal scale, firm size is measured with yearly revenue, IT investment as a ratio of IT investments and revenue, average network duration in years, and network size in terms of number of relations to organizations within the same network. The industry is a single-answer scale with 6-categories which are coded as dummy, while area of cooperation is a categorial multi-answer scale of 8 categories and also coded as dummy. Categories are according to the overview in Table B-22.

### 2.4.2 Sampling frame and data collection

The sampling frame in this investigation was provided by Cluster Observatory[6], an online database for regional network clusters in Europe, consisting of a variety of regional network types such as research networks, supply chains, and engineering networks. A list of organizations from German clusters was obtained from this database, and email invitations were sent out targeting the person in the organization that is most knowledgeable regarding to network cooperation with the respective cluster.

A web-based survey questionnaire was developed for this investigation, with measurement scales translated to German by the authors. The personalized emails asked the managers to refer their answers in the questionnaire to the network that emerged from the specific cluster as stated on Cluster Observatory. In cases of several networks, participants were asked to base their answers in the questionnaire on the network formation with which they are most familiar. Moreover, participants were given a brief description of examples of network instances within a typical cluster. Participants were asked to answer all questions through the lens of a single organizational entity where they might be employed. All IT alignment measures were supplemented with explanations and various examples of inter-organizational processes and systems. Structure, clarity, ambiguity, and completeness of the questionnaire were reviewed by three academic researchers and five field experts. The pretests resulted in minor wording alterations to improve clarity and modifications of the layout. One follow-up email was sent to encourage response.

### 2.4.3 Descriptive statistics and data screening

The sampling method above resulted in an effective sample frame size of 2,830 firms, of which 251 surveys were completed. Ten questionnaires were discarded due to quality criteria such as missing values, the implausibility of demographics, or network characteristic answers, reducing the sample size to 241 firms.

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6 http://www.clusterobservatory.eu/.

*Table B-22. Sample characteristics*

| **Firm characteristics** | | **Network characteristics** | | **Respondent characteristics** | |
|---|---|---|---|---|---|
| **Firm size** | | **Area of cooperation** | | **Position** | |
| Small, up to 49 employees | 54 % (52 %)* | Research and development | 62 % | Managing director / CEO | 59 % |
| | | Marketing | 30 % | | |
| Medium, 50–249 employees | 22 % (20 %)* | Sales | 20 % | Line manager | 22 % |
| | | Operations | 20 % | IT manager / CIO | 10 % |
| Large, at least 250 employees | 24 % (28 %)* | Service | 19 % | Other | 9 % |
| | | Procurement | 13 % | | |
| | | Logistics | 10 % | **Job experience** | |
| **Industry** | | Other | 14 % | Up to 5 years | 6 % |
| Manufacturing | 36 % (39 %)* | **Network duration** | | Between 6 and 10 years | 15 % |
| Professional, scientific, and technical activities | 24 % (27 %)* | Up to 5 years | 36 % | Between 11 and 20 years | 31 % |
| | | Between 6 and 10 years | 32 % | Between 21 and 30 years | 30 % |
| Information and communication | 18 % (16 %)* | Between 11 and 15 years | 17 % | More than 30 years | 18 % |
| | | More than 15 years | 15 % | | |
| Wholesale, retail trade, and logistics | 6 % (6 %)* | | | **Age** | |
| | | **Network size** | | Up to 30 years | 4 % |
| Financial and insurance activities | 3 % (2 %)* | Up to 5 members | 42 % | Between 31 and 40 years | 15 % |
| | | Between 6 and 10 members | 30 % | Between 41 and 50 years | 24 % |
| Other | 13 % (10 %)* | Between 11 and 50 members | 18 % | Between 51 and 60 years | 40 % |
| | | More than 50 members | 10 % | Above 60 years | 17 % |

*Note: * Numbers in brackets are estimated characteristics from the population;*
*Area of cooperation was captured as a multiple-answer question, all other variables as single-answer question*

Overall return rates of around 10 percent are typical for email-based surveys in supply chain and network research (Chen et al. 2013; Im and Rai 2008). However, low response rates bear the risk of non-response bias, i.e., the answers of respondents differing from the potential answers of those who did not answer. To test for non-response bias, we followed two common procedures. First, we analyzed differences between early and late respondents. It is argued that late respondents are similar to those who did not respond (Armstrong and Overton 1977). A t-test revealed no significant differences ($p > .05$) between early and late respondents for any measure. Second, we aimed at comparing firm characteristics of the survey sample and the database. To accomplish this, we took another random sample ($n = 250$) from our database and collected information on firm size and industry (see Table B-22). A chi-squared test on homogeneity revealed no significant differences for both firm size (chi-squared = 1.29, $p > .05$) and industry (chi-squared = 2.55, $p > .05$). We conclude that non-response bias does not appear to be an issue in this investigation.

To counteract biases caused by data collection by a single informant, we employed different procedural remedies for common method variance (Podsakoff et al. 2012). Procedural remedies included a cover story with detailed descriptions and examples as well as the usage of well-developed scales, which both decrease bias through ambiguous questions. Respondents were further motivated to respond accurately by saying that their opinion is valued and telling them that there are no wrong answers, which have been shown to decrease social desirability bias. We underlined the benefit for the responding organization by giving them the opportunity to receive a full analysis and report, as promising feedback has been shown to motivate participants to respond more accurately. We allowed for scale types and anchor label variation in the questionnaire to decrease motivation to respond stylistically. Furthermore, we employed the comprehensive CFA marker technique in order to detect a common post hoc method bias (Williams et al. 2010). We chose a shortened version of individual's Willingness to Learn as the theoretically unrelated marker variable (Schwarz et al. 2017). The 5-point Likert measure comprised two items ("I enjoy learning new things" and "Continuous learning is important to me"). Based on the results of a CFA which included the full research model (except for dummy control variables due to estimation issues), we computed a Baseline (chi-squared = 1077.9, df = 521) and a Method-C model (chi-squared = 1076.2, df = 520). Following this method, we conducted a chi-squared difference test on the model fit values (chi-squared = 1.7, df = 1). The results indicate no support for the hypothesis that a restricted model with a fixed correlated marker variable (Method-C model) better fits the data than a model with the marker variable assumed to be orthogonal to the model (Baseline model).

Finally, we also tested if individual characteristics of the respondents potentially bias estimations by conducting a series of t-tests for position, age, job experience, and IT competence on the items of the research variables. IT competence was measured by splitting the sample in IT and non-IT positions. We find no significant differences. In summary, we conclude that common method bias and respondents' individual characteristics are not a major concern for the validity of our results.

## 2.5 Data Analysis and Results

To ensure the fit between empirical data and the research model, the quality of the measurement model was first assessed for validity and reliability of the latent variables, followed by estimation and analysis of the structural models. Mediation analysis was subsequently conducted to examine the extent to which inter-organizational IT alignment mediates the impact of the lower-order capabilities on relationship performance.

For our statistical analysis, we applied a structural equation approach. Due to the exploratory nature of theory development in the field of inter-organizational IT alignment, we selected a prediction oriented method for the primary analysis. In line with this argumentation, we decided for partial least squares method (PLS) over covariance-based approaches and focused on maximizing the explanatory power rather than evaluating an overall model fit (Gefen et al. 2011; Ringle et al. 2012). Our analysis was primarily supported using the software SmartPLS 2.0.M3 (Ringle et al. 2005), with IBM SPSS Statistics 21 and SPSS Amos 21 employed for tests that are unavailable in the SmartPLS packages.

### 2.5.1 Measurement model assessment

To evaluate the robustness of our scales, we performed an exploratory factor analysis of all latent constructs as a first step. The results generally confirm the structure of the measurement model. Two items of the control variable environmental turbulence were dropped due to low factor loading (< .5). All other items highly load on their respective dimension. No concerning cross-loadings were detected. Detailed results along with their descriptive statistics, can be found in the Appendix (see Table B-27).

*Table B-23. Construct means, standard deviations, and inter-construct correlations*

| Latent variable | Mean | SD | FL | CR | AVE | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Relationship performance | 2.238 | 1.050 | .750 - .910 | .933 | .737 | **.858** | | | | | |
| 2. Inter-organizational IT alignment | 3.115 | 1.004 | .712 - .857 | .911 | .673 | .449 | **.820** | | | | |
| 3. IT infrastructure integration | 3.746 | 1.556 | .838 - .927 | .952 | .769 | .542 | .455 | **.877** | | | |
| 4. Information capabilities | 2.654 | 1.110 | .873 - .920 | .948 | .785 | .368 | .532 | .469 | **.886** | | |
| 5. IT-enabled coordination | 2.735 | 1.027 | .775 - .892 | .930 | .690 | .470 | .362 | .489 | .492 | **.831** | |
| 6. Environmental turbulence | 4.095 | 1.658 | .962 - .964 | .963 | .928 | .174 | .192 | .205 | .226 | .234 | **.963** |

*Note: Inter-organizational IT alignment and environmental turbulence were measured using a Likert scale ranging from 1–7, all other constructs range from 1–5; SD = Standard deviation; FL = Factor loading; CR = Composite reliability; Diagonal elements are the square root of AVE calculated for each construct, and off-diagonal elements are the correlations between the constructs.*

We used PLS model estimations (model specification according to Model 2 in Table B-24) to further test for convergent and discriminant validity of the measurement model. In line with the original construct specification, all latent constructs were modeled as reflective. Convergent validity refers to whether items measuring a construct correspond with one another. We evaluated each latent variable for convergent validity using three measures: individual item reliability, composite construct reliability (CR), and average variance extracted (AVE). The results are shown in Table B-23. All items significantly load on their respective construct above the threshold of .7 (Hulland 1999). Furthermore, all CRs lie above the acceptable limit of .70 (Bagozzi and Yi 1988), and each AVE also exceeds the lower bound of .50 (Bagozzi and Yi 1988). Discriminant validity refers to whether theoretically distinct concepts are empirically distinct from one another, which was assessed using the criterion of Fornell and Larcker (1981). As the AVE for each construct is greater than the variance shared with other constructs as shown by the square root AVEs on the diagonal in Table B-23, discriminant validity can be confirmed. Our analyses suggest that our measurement model is both acceptable and reliable.

### 2.5.2 Structural model analyzes

After estimating the measurement model, we computed eight PLS estimations. Model 1 serves as a baseline that predicts the dependent variables solely using controls. A full model such as Model 2 is specified according to the hypotheses H1 – H4 (see Table B-24). It predicts inter-organizational IT alignment by IT infrastructure integration, information capabilities, and IT-enabled coordination, including all controls. The six estimations for Model 3a, b, c and Model 4a, b, c are intended to test the mediation hypotheses H5a, b, c (see Table B-24).

Unlike other covariance-based SEM techniques, PLS does not provide global validation indices per se. Instead, the structural model is usually assessed according to the amount of variance explained in the endogenous constructs (Hulland 1999). The results reveal that the full model explains a substantial amount of variance in both inter-organizational IT alignment ($R^2 = .440$) and relationship performance ($R^2 = .315$). Moreover, a comparison of Model 1 and Model 2 indicates that the proposed structure of the full model significantly improves explanation of the dependent variables than the baseline model. We also estimated the Stone-Geisser $Q^2$ coefficient using the blindfolding procedure for Model 2. All $Q^2$ values lie clearly above the threshold of 0, indicating the model's overall predictive relevance (Chin 1998). To evaluate the significance of the paths in the structural models, we applied the bootstrapping resampling procedure (with 1,000 samples).

The results of Model 2 further indicate support for H1, implying a significant influence of inter-organizational IT alignment on relationship performance ($b = .511$, $p < .01$). We find significant path coefficients for intergrated IT infrastructure ($b = .336$, $p < 0.1$), information capabilities ($b = .179$, $p < .01$) and IT-enabled coordination ($b = .205$, $p < .01$), providing empirical support for H2, H3 and H4.

For the control variables, we find significant effects for environmental turbulence ($b = .182$, $p < .05$), network size ($b = .157$, $p < .05$) and IT investment ($b = .182$, $p < .01$) on inter-organizational IT alignment, and for environmental turbulence on relationship performance ($b = .197$, $p < .01$) in the baseline model. In the full model, the only path which remains significant is the effect of IT investment on inter-organizational IT alignment ($b = .118$, $p < .05$).

*Table B-24. Results of PLS-based regression for baseline and full model*

| | **Model 1: baseline** (controls only) | | **Model 2: full model** (controls + fully mediated model) | |
|---|---|---|---|---|
| **Dependent variable** | Inter-organizational IT alignment | Relationship performance | Inter-organizational IT alignment | Relationship performance |
| **Independent variables** | | | | |
| Inter-organizational IT alignment | | | | .511** |
| IT infrastructure integration | | | .336** | |
| Information capabilities | | | .179** | |
| IT-enabled coordination | | | .205** | |
| **Controls** | | | | |
| Environmental turbulence | .182* | .197** | .057 | .165 |
| Environmental turbulence x inter-org. IT alignment | | | | -.092 |
| Network size | .157* | .101 | .087 | .032 |
| Network duration | .029 | .116 | -.001 | .111 |
| Area of cooperation dummy variables: | | | | |
| Research and development | -.079 | -.052 | -.044 | -.013 |
| Marketing | .076 | .030 | .077 | -.004 |
| Sales | .031 | .041 | .023 | .027 |
| Operations | .045 | -.043 | .033 | -.065 |
| Service | .000 | .095 | -.055 | .095 |
| Procurement | -.079 | -.106 | -.031 | -.070 |
| Logistics | .085 | .092 | .061 | .054 |
| Revenue | .023 | .025 | .023 | .014 |
| IT investment | .182** | .036 | .118* | -.045 |
| Industry dummy variables: | | | | |
| Manufacturing | .101 | -.045 | .087 | -.092 |
| Professional, scientific, and technical activities | .079 | .054 | .076 | .020 |
| Information and communication | .026 | .028 | .015 | .015 |
| Wholesale, retail trade, and logistics | .104 | -.057 | .054 | -.107 |
| Financial and insurance activities | .001 | .021 | .023 | .020 |
| $R^2$ | **.152** | **.139** | **.440** | **.315** |
| ∆ R2 for inter-organizational IT alignment | | | **.288**** | |
| ∆ R2 for relationship performance | | | | **.176**** |

*Note: Numbers indicate path coefficients; bold numbers are R2 squared values; * p ≤ .05; ** p ≤ .01; significance of path coefficients is computed with bootstrapping resampling procedure; significance of ∆R2 values is computed with pseudo F-statistics.*

### 2.5.3 Mediation analysis

The analysis of the direct path coefficients in the full model reveals the significant direct influence of IT infrastructure integration, information capabilities, and IT-enabled coordination on inter-organizational IT alignment and its influence, in turn, on relationship performance. This provides first evidence of the distinction between lower- and higher-order capabilities. However, in H5a, b, c we proposed that relationship performance is derived from inter-organizational IT alignment, and that the effect of lower-order capabilities on relationship performance can be explained through inter-organizational alignment. To better understand this mechanism, we separately tested these effects using mediation analysis techniques (Baron and Kenny 1986; Shrout and Bolger 2002).

In PLS-based mediation analysis, high mediator reliability is a precondition. When indirect effects are included in the structural model, variance-based estimations may lead to overestimated direct effects. However, unstable estimations can be avoided if the mediator is measured almost perfectly (Henseler 2012). Since IT alignment shows high construct reliability scores that are above the typical thresholds (individual item reliability > .7 and CR > .9), we argue that this is not a concern for our mediation analysis.

In mediation analysis (Baron and Kenny 1986), the first step is to test the significance of the direct effect of the causal variable (i.e., each lower order capability) on the outcome variable (i.e., relationship performance) without including the mediator (i.e., the higher-order capability inter-organizational IT alignment). Direct effects were tested in Model 3a, b, c, resulting in significant direct effects for all three lower-order capabilities. The second and third prerequisites for mediation include a significant effect of the causal variable on the mediator and a significant effect of the mediator on the outcome variable. We therefore created corresponding estimations for each lower-order capability in Model 4a, b, c. The models follow the specification of the full model (Model 2) but include an additional direct path from the causal variable to the outcome variable. The results reveal both a significant effect of all lower-order capabilities on inter-organizational IT-alignment, as well as a significant effect of inter-organizational IT-alignment on relationship performance. We further tested the significance of the indirect effects and used bootstrapping results from Model 4a, b, c estimations (Preacher and Hayes 2004). The results reveal significant indirect effects for all three lower-order capabilities. Accordingly, we find support for H5a, b, c in our data, indicating that all three lower-order capabilities are mediated by inter-organizational IT alignment.

In the last step, we want to determine the size of the mediating effect. We calculated the variance accounted for (VAF), which is the ratio between the indirect and total effects. A VAF above .20 indicates partial mediation while values above .80 imply full mediation (Shrout and Bolger 2002). As depicted in Table B-25, the estimation results of Model 3a, b, c and Model 4a, b, c commonly suggest that IT infrastructure integration, information capabilities, and IT-enabled coordination are partially mediated by inter-organizational IT alignment.

*Table B-25. Mediation analysis of inter-organizational IT alignment*

| Lower-order capability | Model 3a, b, c (controls + IV + DV) | | Model 4a, b, c (controls + IV + M + DV) | | | | | VAF |
|---|---|---|---|---|---|---|---|---|
| | IV → DV | R2 | IV → M | M → DV | IV → M → DV (indirect path) | IV → DV (direct path) | R2 | |
| a. IT infrastructure integration | .477** | .331 | .347** | .437** | .152** | .323** | .398 | .320 |
| b. Information capabilities | .351** | .240 | .166** | .482** | .080** | .176** | .353 | .313 |
| c. IT-enabled coordination | .484** | .329 | .200** | .454** | .091** | .347** | .415 | .208 |

*IV = Independent variable (respective lower-order capability); M = Mediator (i.e., inter-organizational IT alignment); DV = Dependent variable (i.e., relationship performance); VAF = Variance accounted for; * p < .05, ** p < .01*

## 2.6 Discussion

### 2.6.1 Summary of findings

The results provide empirical support for the general concept of IT alignment as a dynamic capability in inter-organizational networks. According to the dynamic capability theory, IT investments lead to increased business value when firms develop capabilities to adapt their resources and strategies to environmental changes. This study suggests that inter-organizational IT alignment is one such capability; ensuring the fit between IT and business and the appropriate use of IT. Consequently, it is an important source of relationship performance, which was empirically demonstrated by a significant effect in our research model. The results mirror findings from other studies which reveal a relationship between IT alignment and business value in single firms (Gerow et al. 2014) and supply chains (Kim et al. 2013; Sanders 2005; Wu et al. 2006). Consequently, IT alignment also plays a critical role in inter-organizational networks resulting in reduced operational costs, increased revenue, productivity, flexibility, improved launch of new products and services, and better service quality.

Furthermore, we hypothesized three antecedents of inter-organizational IT alignment in our research model, i.e., IT infrastructure integration, information capabilities, and IT-enabled coordination, finding clear evidence for all three. Our data supports the role of IT infrastructure integration as the first antecedent and backbone (Prasad et al. 2013) of inter-organizational networks, making the support of inter-organizational processes possible. Although less integrated IS, such as email, can support inter-organizational activities (Chi and Holsapple 2005), there is nothing idiosyncratic about these systems (Bharadwaj et al. 2007; Saraf et al. 2007). Therefore, they are less likely to contribute to IT alignment to the same extent as integrated systems. Second, developing information capabilities to electronically share large amounts of high quality information between network partners is crucial for reducing uncertainty and developing higher-order capabilities (Malhotra et al. 2005). Our results show that information capabilities also contribute to inter-organizational IT alignment. Finally, inter-organizational systems improve planning and decision-making between network partners while reducing opportunistic behavior (Im and Rai 2014; Wang et al. 2013). The results of our study indicate that this is also important for achieving inter-organizational IT alignment by showing a significant effect of IT-enabled coordination. In summary, our findings reveal that IT infrastructure integration, information capabilities, and IT-enabled coordination are important antecedents of inter-organizational IT alignment and therefore create favorable conditions for achieving the complex task of aligning inter-organizational IT and business infrastructures and processes.

Moreover, our results indicate that inter-organizational IT alignment can be seen as a higher-order capability. Although IT infrastructure integration, information capabilities, and IT-enabled coordination have positive direct effects on relationship performance, the full value of these capabilities can only be realized by ensuring a fit between inter-organizational IT and business infrastructures and processes. Inter-organizational IT capabilities might be ineffective when support of inter-organizational business processes and activities is not ensured, for example if electronically shared information is not exploited in networked business processes. Moreover, the capabilities might become ineffective due to environmental changes. For example, network IT infrastructures must make use of emerging technologies in order to differentiate the network from competitors (Bharadwaj 2000) and networks might be pressured to introduce new forms of collaboration or renew their governance structures as a result of technological advancements (Prasad et al. 2010). IT alignment is an inter-organizational dynamic capability that ensures adaptation by aligning IT with business resources and capabilities. This was demonstrated by the partially mediating effect of inter-organizational IT alignment regarding the three lower-order capabilities. However, partial mediation also implies a direct influence independent from the capability to align business and IT. One explanation might be that the development of inter-organizational IT capabilities in general reflects close collaboration between network partners. Considering this, there might be non-IT related capabilities and value co-creation mechanisms in place such as complementary capabilities (Dyer and Singh 1998) and organizational higher-order capabilities (Rai et al. 2006) that additionally influence relationship performance. Nevertheless, our results indicate that inter-organizational IT alignment is necessary to leverage the benefits of inter-organizational IT capabilities fully, which is an important explanatory factor in the IT capability building process for co-creating value.

### 2.6.2 Theoretical contributions

The overarching contribution of this study lies in the integration of IT alignment in IT-based value co-creation research. We therefore contribute to the literature regarding both value creation through inter-organizational IT capabilities and IT business alignment.

Consistent with dynamic capability theory, our findings emphasize the need for aligning networked IT with business infrastructures and processes that reach beyond development of inter-organizational IT capabilities across network partners in order to improve relationship performance. Scholars employed mixed approaches to investigate the relationship between inter-organizational IT capabilities and performance outcomes. While some studies assume that inter-organizational IT capabilities and performance outcomes are directly interrelated, others conceptualize the relationship as indirect (Dong et al. 2009; Rai et al. 2006). These different conceptualizations limit the comparability of results, which is further enhanced by insignificant findings (e.g., Saldanha et al. 2013). To improve comparison and understanding of how inter-organizational IT capabilities lead to superior performance outcomes, our study utilizes inter-organizational IT alignment, or the dynamic capability to ensure a fit between IT and business infrastructures and processes in networks, as a differentiator between the two conceptualizations. Our findings reveal that inter-organizational IT alignment improves the explanatory power of the model by significantly mediating the relationship between inter-organizational IT capabilities and relationship performance. Therefore, we contribute to the view that the value of inter-organizational IT results from its impact on higher-order (Rai et al. 2006; Zhu et al. 2015) and dynamic (Lim and Melville 2012; Liu et al. 2013; Rai and Tang 2010) capabilities.

Second, our study contributes to IT alignment literature in two ways: First, the results demonstrate the performance enhancing effect of alignment for inter-organizational networks, which extends findings in single firms (Gerow et al. 2014) and supply chains (e.g., Sanders 2005; Seggie et al. 2006; Wu et al. 2006). In particular, our findings support the interpretation of alignment as a dynamic capability (Chen et al. 2008; Leonard and Seddon 2012; Schwarz et al. 2010) and as an explanation for value creation in inter-organizational contexts. Moreover, studies on IT alignment at the infrastructural and process-level found mixed results so far and argue that the value of alignment at this level may depend on the context (Gerow et al. 2016; Queiroz 2017). Our results reveal that inter-organizational business and IT infrastructures and processes have significant performance effects. This type of alignment seems to be particularly relevant in the context of inter-organizational networks. Second, by examining antecedents, we can show that developing inter-organizational IT capabilities facilitates the complex challenge (Katzy et al. 2016) of achieving inter-organizational IT alignment.

### 2.6.3 Managerial implications

This study provides important insights into how network managers can achieve inter-organizational IT alignment for favorable relationship outcomes. The first insight suggests that managers should recognize inter-organizational IT alignment as a central source of competitive advantage. Despite the potential advantages of inter-organizational IT systems, IT-related investments per se will not necessarily lead to competitive advantage and thus business value for network partners. Achieving inter-organizational IT alignment among network partners can be particularly challenging and conflicting due to informal decision-making or diverging goals among the member organizations. This is the central mechanism that transforms IT investments into value, and is, therefore, necessary to explicitly build management capabilities that can handle the ongoing dynamics, such as partner (de-)integration, and IT transformation along these requirements.

Our study also offers recommendations for management capabilities fostering the establishment of inter-organizational IT alignment. Network managers should link intra- and inter-firm IT and couple them with a network infrastructure to combine information and perspectives from all network partners. With integrated IT, managers can generate inferences from past events and learn how to improve alignment effectiveness. Moreover, the sharing of tactical and strategic information based on collaborative IT leads to additional benefits for network members, namely a more effective alignment of network processes and systems. Network managers should also evaluate their current systems for coordinating inter-organizational activities. However, it is crucial to ensure a fit between inter-organizational business and IT in order to fully realize the anticipated benefits of these capabilities.

### 2.6.4 Limitations and avenues for further research

As with other studies, it is important to discuss limitations in applying the insights from this study. The target population of regional networks in Germany might be considered the primary limitation of this investigation. Although we found substantial variations in IT-related capabilities and their respective IT alignments, regional networks have unique characteristics which may not be generalizable to other areas or cultures. As discussed earlier, these networks are characterized by high trust. In addition, the results indicate that members of regional networks prefer face-to-face meetings, rather than communication through IOS. However, regular meetings might be difficult in geographically distributed networks (Provan and Kenis 2007), resulting in increased IT alignment complexity. Consequently, although regional networks provide an appropriate target population for studying inter-organizational IT alignment, the results of the study may, to some degree, not be generalizable. Therefore, additional research analyzing other types of collaboration and in a different cultural context is necessary to substantiate our findings.

A second limitation lies in the choice of capturing data. Data is collected from a single key informant, possibly subjecting results to a common method bias. As described earlier, we took various pre-hoc measures to avoid any subsequent systematic inflation/deflation in measurement reliability and structural paths. The post hoc analyses employed the comprehensive CFA marker technique which gives no indication that our data suffer from such a bias. Nevertheless, these results should be interpreted in light of known threats of the single informant approach. Moreover, using correlations of IT capabilities and IT success measures that are collected at a single point in time poses another possible limitation, as effects may be time sensitive. This can particularly hold for the context of inter-organizational networks because they might be even less responsive to procedural and structural changes than changes within single organizations (Kim et al. 2006). A superior design would involve tracking changes in the capabilities and the resulting performance in a more comprehensive longitudinal study. However, studies that follow a cross-sectional questionnaire-based single informant design can often take early steps in a new direction, building a solid base for further research. Building upon our findings, more studies with longitudinal data, different data collection approaches, and varying analysis techniques are neccessary to confirm the viability of these claims.

More research should be conducted to more thoroughly investigate the concept of inter-organizational IT alignment and its relation to inter-organizational IT capabilities. As discussed in the introduction, this may be the first investigation examining antecedents to inter-organizational IT alignment. While the results confirm that the dynamic capability framework provides a strong theoretical basis for examining mechanisms for inter-organizational IT alignment, the consideration of mechanisms that are contingent to the environmental context (such as path dependencies and structural inertia) can enrich the understanding alignment's contribution to the value proposition. Furthermore, as a higher-order capability, inter-organizational IT alignment might also influence and change lower-order capabilities (Daniel et al. 2014), leading to feedback loops and increasingly complex processes which should be further analyzed. Lastly, it should be acknowledged that there might be relationships between the lower-order inter-organizational IT capabilities. For instance, it may be argued that standardized information sharing between network partners leads to improved IT-enabled decision-making (Wong et al. 2015). While the focus of this study is to introduce the concept of IT alignment into this research stream, conceptualizing interdependencies between inter-organizational IT capabilities can provide additional insights into the IT-related mechanisms of IT-based value co-creation (Grover and Kohli 2012).

## 2.7 Appendix

*Table B-26. Latent construct scales*

| | |
|---|---|
| **Relationship performance (REP)** | |
| Definition: *Benefits realized by the firm that are attributable to cooperating in the network relationship.* | |
| Source for measurement: Adapted from Im and Rai, 2014; Klein and Rai, 2009. | |
| Scale: 1 - 5 | |
| By working with the network partners, we have received the following benefits over the past three years: | |
| REP01 | Reduced operational costs |
| REP02 | Increased revenue |
| REP03 | Increased productivity |
| REP04 | Improved service quality |
| REP05 | Improvement in the launch of new products / services |
| REP06 | Increased flexibility |
| **Inter-organizational IT alignment (ITA)** | |
| Definition: *The degree to which the network business infrastructure and processes fit the network IT infrastructure and processes and vice versa.* | |
| Source for measurement: Adapted from Gerow et al., 2015. | |
| Scale: 1 - 7 | |
| IA1 | IT processes support business processes within the network. |
| IA2 | IT processes are adapted to business processes within the network. |
| IA3 | IT processes and business processes match each other within the network. |
| IA4 | The fit between IT infrastructure and business infrastructure is identified within the network. |
| IA5 | IT infrastructure and business infrastructure correspond to each other within the network. |
| IA6 | IT infrastructure aligns with business infrastructure within the network. |
| **IT infrastructure integration (III)** | |
| Definition: *The extent to which the IS applications of a focal firm work as a functional whole in conjunction with the IS applications of its network partners.* | |
| Source for measurement: Adapted from Saraf et al. 2007, 2012. | |
| Scale: 1 - 5 | |
| III01 | Data are entered only once to be retrieved by most applications of our network partners. |
| III02 | We have successfully integrated most of our databases with the ones of our network partners |
| III03 | We have successfully integrated most of our software applications with the ones of our network partners |
| III04 | Most of our software applications work seamlessly across our network partners |
| III05 | Software applications on multiple machines of multiple vendors are interoperable with each other across our network partners |

*Continued on Page 133*

*Continued from Page 132*

| | |
|---|---|
| **Information capabilities (INC)** | |
| Definition: *The extent to which a firm exchanges tactical and strategic information with network partners based on IS applications.* | |
| Source for measurement: Adapted from Wong et al., 2012. | |
| Scale: 1 - 5 | |
| INC01 | We exchange information with our network partners electronically. |
| INC02 | We work with our network partners electronically on cross-organizational business activities. |
| INC03 | Electronic information shared between our firm and network partners is accurate. |
| INC04 | Electronic information shared between our firm and network partners is timely. |
| INC05 | Electronic information shared between our firm and network partners is standardized. |
| **IT-enabled coordination (ITC)** | |
| Definition: *The extent to which IT is used for planning and coordinating the interdependent activities in which the network partners collectively engage.* | |
| Source for measurement: Adapted from Nicolaou et al., 2011. | |
| Scale: 1 - 5 | |
| ITC01 | The use of IT systems in general has allowed us to better coordinate decisions with the network partners. |
| ITC02 | Our IT systems provide adequate information to make decisions that affect the relationships with the network partners. |
| ITC03 | Our IT systems provide adequate information to plan in advance the potential outcomes of decisions which impact the relationships with the network partners. |
| ITC04 | The use of IT systems collaborative capabilities has allowed us to better coordinate decisions with the network partners. |
| ITC05 | The use of IT systems increases transparency of the network partners cost structure. |
| **Environmental turbulence (ENT)** | |
| Source for measurement: Adapted from Wang et al., 2012. | |
| Scale: 1 - 7 | |
| ENT01 | Products or services become obsolete very quickly in our industry. |
| ENT02 | The product/services technologies change very quickly in our industry. |
| ENT03* | We can predict what our competitors are going to do next. |
| ENT04* | We can predict when our products/services demand changes. |

** dropped items*

*Table B-27. Results of exploratory factor analysis*

| | **Mean** | **Std. dev.** | **Skewness** | **Factor 1** | **Factor 2** | **Factor 3** | **Factor 4** | **Factor 5** | **Factor 6** |
|---|---|---|---|---|---|---|---|---|---|
| III01 | 2.583 | 1.273 | .201 | .117 | .108 | .226 | **.604** | .274 | -.011 |
| III02 | 2.124 | 1.223 | .733 | .203 | .183 | .074 | **.749** | .160 | .115 |
| III03 | 2.167 | 1.231 | .698 | .292 | .158 | .097 | **.848** | .057 | .035 |
| III04 | 2.224 | 1.170 | .478 | .266 | .251 | .088 | **.774** | .159 | .030 |
| III05 | 2.154 | 1.218 | .688 | .183 | .246 | .071 | **.732** | .153 | .025 |
| INC01 | 3.452 | 1.198 | -.448 | .010 | .025 | .166 | .099 | **.708** | .089 |
| INC02 | 2.996 | 1.261 | -.067 | .154 | .097 | .253 | .260 | **.701** | .057 |
| INC03 | 3.266 | 1.231 | -.370 | .139 | .096 | .194 | .074 | **.793** | .003 |
| INC04 | 3.187 | 1.135 | -.373 | .176 | .121 | .202 | .128 | **.732** | .076 |
| INC05 | 2.705 | 1.259 | .131 | .279 | .184 | .179 | .253 | **.600** | .023 |
| ITC01 | 2.929 | 1.320 | -.076 | .211 | .152 | **.742** | .047 | .287 | .094 |
| ITC02 | 2.718 | 1.182 | -.044 | .166 | .240 | **.822** | .096 | .253 | .045 |
| ITC03 | 2.589 | 1.213 | .212 | .119 | .215 | **.806** | .071 | .261 | .043 |
| ITC04 | 2.627 | 1.269 | .167 | .216 | .187 | **.733** | .147 | .227 | .076 |
| ITC05 | 2.407 | 1.295 | .421 | .143 | .250 | **.747** | .203 | .104 | .055 |
| ITA01 | 3.992 | 1.847 | -.115 | **.617** | .206 | .203 | .264 | .248 | .015 |
| ITA02 | 3.552 | 1.701 | .030 | **.567** | .258 | .144 | .294 | .177 | .070 |
| ITA03 | 3.842 | 1.714 | -.196 | **.662** | .151 | .090 | .273 | .264 | -.004 |
| ITA04 | 3.602 | 1.806 | .073 | **.663** | .311 | .185 | .191 | .099 | .120 |
| ITA05 | 3.759 | 1.783 | -.031 | **.949** | .153 | .184 | .170 | .076 | .055 |
| ITA06 | 3.743 | 1.790 | -.010 | **.950** | .149 | .180 | .166 | .075 | .055 |
| REP01 | 2.622 | 1.222 | .181 | .182 | **.734** | .222 | .234 | .044 | .042 |
| REP02 | 2.655 | 1.194 | .120 | .098 | **.704** | .058 | .149 | .013 | .141 |
| REP03 | 2.706 | 1.251 | .049 | .160 | **.808** | .236 | .224 | .084 | .004 |
| REP04 | 2.870 | 1.231 | -.179 | .218 | **.764** | .170 | .097 | .094 | .009 |
| REP05 | 2.674 | 1.243 | .067 | .223 | **.638** | .155 | .135 | .163 | .131 |
| REP06 | 2.882 | 1.260 | -.089 | .120 | **.722** | .219 | .144 | .173 | .041 |
| ENT01 | 4.208 | 1.726 | -.248 | .071 | .127 | .101 | .070 | .060 | **.835** |
| ENT02 | 3.983 | 1.716 | -.113 | .083 | .112 | .084 | .045 | .119 | **.978** |

*Extraction method: Maximum Likelihood; Rotation method: Varimax with Kaiser-Normalization; Fixed number of factors: 6; Bolded numbers are factor loading above .5; III = IT infrastructure integration; INC = Information capabilities; ITC = IT-enabled coordination; ITA = Inter-organizational IT alignment; REP = Relationship performance; ENT = Environmental turbulence*

## III. Theory Adaptation: Business Value Dimensions and Contextual Factors of IT-Based Value Co-Creation in the Wood Industry

While the previous chapter (B.II) provided cross-industrial insights on IT-based value co-creation, this chapter aims to instantiate and modify the findings to the specific context of the wood industry. According to the followed reference theorizing approach, this aim relates to its last step, namely theory adaptation. By investigating contextual factors and by unfolding the business value in the wood industry, answers to the third research question are provided. Supply chains in the wood industry represent the unit of analysis.

This chapter includes two studies which apply the IT-based value co-creation mechanisms to organizations in the wood industry, with one focusing on the influence of contextual factors, and the other one on dimensions of business value. Study #5 conceptualizes IT-enabled collaboration as an information processing capability and a driver of supply chain performance. The moderating role of environmental uncertainties as contextual factors is further examined. Study #6 introduces resource efficient production as a new business value dimension by means of developing a new construct. Moreover, the study investigates the impact of IT alignment as a higher-order dynamic capability on resource efficiency, mediating the effect of lower-order IT integration. Overall, both studies collect survey-based data in the wood industry to validate their respective research models.

# 1 Study #5: IT Value under Environmental Uncertainty

*Table B-28. Fact sheet of Study #5*

| | |
|---|---|
| Title | Shifting from Justification to Understanding: The Impact of Environmental Uncertainty on the Value of IT-Enabled Collaboration in Supply Chains |
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| Outlet | Proceedings of the European Conference on Information Systems (ECIS) 2016, Completed Research Paper |
| Abstract | After over two decades of IT value research, there is growing evidence that organizations bene-fit from investments in IT. Hence, it is time to shift from justifying IT value to understanding the conditions under which it occurs. Although the relevance of contextual factors for the impact of IT investments has been highlighted in several studies, the literature is still too limited to draw a clear representation. This study contributes to the nascent stream that incorporates contextual factors with regard to the impact of IT investments on performance outcomes. By drawing on organizational information processing theory, we develop a research model and propose that the relationship between IT enabled collaboration and supply chain performance is moderated by several dimensions of environmental uncertainty, namely product complexity, technological uncertainty, demand uncertainty, and supply uncertainty. Based on an analysis of data gathered from 150 supply chain executives, the study sheds light on the salient question of the conditions under which IT creates value in the context of supply chains. The findings advance the knowledge frontier of IT value research by providing evidence that performance outcomes are contingent on various environmental conditions and offering an explanation for the mixed results observed in previous literature. |
| Keywords | IT value; IT-enabled collaboration; Supply chain performance; Environmental uncertainty |

## 1.1 Introduction

During the past two decades, nothing has changed business operations like the emergence of the Internet and its related information and communication technologies have (Johnson and Whang 2002; Sanders 2007). This rapid growth of information technology (IT) and web-based information sharing has particularly influenced the field of supply chain management (SCM), which is founded on the collaboration among supply chain partners (Narasimhan and Jayaram 1998; Sanders 2007; Vaharia 2002). As a result, IT-enabled collaboration across partnering organizations has become the backbone of supply chain business structures. It is seen as an essential enabler of SCM activities because it facilitates information sharing, thereby enhancing organizational flexibility and responsiveness while minimizing risk and inventory costs (Rajaguru and Matanda 2013). Consequently, fostering supply chain collaboration via information and communication technologies has generated much excitement in both research and practice (Rai et al. 2006; Rosenzweig 2009).

Therefore, academics have extensively examined the relationships between IT-related investments and organizational performance and, more recently, how multiple organizations can collectively leverage IT to co-create value from investments in IT (Grover and Kohli 2012). Despite controversial empirical findings on the relationship between IT-related investments and economic outcomes, there is growing evidence that IT does create value under certain conditions in general (Masli et al. 2011; Melville et al. 2004; Staiger 2004) and in terms of supply chain performance (SCP) in particular (Klein and Rai 2009; Wang et al. 2013; Wu and Chuang 2010).

However, if the value of a best practice, such as IT-enabled supply chain integration and collaboration, is supported by empirical evidence, research should shift from the justification of its value to the understanding of the contextual conditions under which it occurs (Sousa and Voss 2008). Among other factors, environmental uncertainty (EU) has been emphasized as an important contextual factor that may affect the general effectiveness of a best practice (Souder et al. 1998; Venkatraman 1989), particularly the relationship between supply chain integration and performance (Jean et al. 2008; Koufteros et al. 2005; Wong et al. 2011).

Though the relevance of such contextual factors with regard to the impact of IT investments has been highlighted in several studies (e.g., Melville et al. 2004, 2007; Wade and Hulland 2004), prior research has focused primarily on investigating the environmental conditions that drive or mediate information integration and IT-enabled collaboration rather than examining how these conditions moderate performance outcomes (Jean et al. 2008; Wong et al. 2012). As a result, research on this topic remains scarce.

Of the literature that does exist, findings are rather limited. First, most studies that consider the moderating role of contextual factors focus solely on internal firm characteristics and neglect the influence of industry or macroeconomic factors, such as EU (Schryen 2013). Second, evidence reported thus far is contradictory, as empirical results indicate that EU does not always moderate relationships between supply chain integration and performance. Furthermore, even if moderating effects exist, their direction varies (Wong et al. 2011). Third, the variety of approaches in conceptualizing EU and performance prohibits a meaningful comparison of results or conclusions about the contingent effects. Fourth, and perhaps most importantly, there is a lack of conceptual foundations in information systems (IS) research that can provide a theoretical explanation for the varying moderating role of contextual factors with regard to the relationship between IT investments and performance outcomes (Jean et al. 2008).

In sum, the body of literature on the importance of various contextual factors for the relationship between IT-related investments and performance is still too small to draw any clear picture, particularly from an IS perspective (Jean et al. 2008; Schryen 2010, 2013). Thus, by examining the conditions under which IT-enabled collaboration creates value in terms of SCP, this study contributes to the nascent stream of IT business value research, which incorporates contextual factors with regard to the impact of IT investments. In particular, the study aims to offer insights into the conditions under which IT creates value. Therefore, we developed and empirically tested a theoretical model to examine the contingent role of EU.

By doing so, this study differs from previous and related research endeavors in a number of aspects. As research on IT value has highlighted the need to examine how multiple organizations can leverage IT to co-create value (Kohli and Grover 2008), we focus on SCP as a dependent variable rather than on individual firm performance. Moreover, to capture a broader scope, we operationalize SCP as a multidimensional construct, reflecting four different outcome dimensions. We concentrate on the sources of EU that have been regarded as most relevant in supply chain contexts. In addition, and in contrast to approaches applied in former studies (e.g., Wade and Hulland 2004; Wong et al. 2012, 2011), we collapse the construct of EU into four dimensions, which enables us to adopt a more differentiated perspective. Furthermore, we draw upon the information processing view (Galbraith 1973) as a conceptual foundation for our study because it offers valuable insights for research on IT value in the presence of EU. Lastly, we follow the very recent suggestion of Sabherwal and Jeyaraj (2015) for the design of studies on IT value and concentrate on a single relationship between an IT-based independent variable and a dependent variable to strengthen the focus our study.

The remainder of this paper is structured as follows. In the next section, we provide a background on organization information processing theory (OIPT) and elaborate upon our conceptualization of IT-enabled collaboration. We then present our theoretical framework and derive hypotheses. Afterwards, we outline the design and procedure of the empirical investigation. We then reflect upon the implications of this study, concluding with limitations and suggestions for future research.

## 1.2 Theoretical Background

In this section, we first discuss OIPT as a conceptual foundation for our study and define the relevant contextual factors with regard to EU in supply chains. We then highlight and clarify the role of IT-enabled collaboration as an information processing capability.

### 1.2.1 Organizational information processing theory

The information processing view of the firm argues that organizations need quality information to cope with uncertainty and improve their decision making. It posits that resolving uncertainty, defined as a lack of information, is the central task in organizational design, highlighting the strategic importance of information processing for interorganizational activities in supply chains (Galbraith 1973). This notion of OIPT is consistent with contingency theory, which suggests that performance depends on the alignment between an organization's structure and its environmental conditions (Sillince 2005). However, while contingency theory only posits the need for alignment, OIPT extends this perspective by providing a theoretical reason explaining why such alignment is valuable in improving performance. In particular, OIPT emphasizes the importance of aligning information processing capabilities with information processing needs, which arise from uncertainties, in order to reach performance gains (Grover and Saeed 2007; Premkumar et al. 2005; Wong et al. 2015).

Information processing theorists have proposed various sources and types of uncertainty that can vary across and within different organizations (Gattiker and Goodhue 2004; Wong et al. 2015). However, we focus on EU because it has been regarded as an inherent condition of interorganizational interaction in supply chains (Miller 1987; Wong et al. 2011). Previous research has identified two major dimensions of EU, namely complexity and dynamism

(Duncan 1972; Miller and Friesen 1982). While complexity captures the number of factors and their interactions relevant to decision making, dynamism involves the relative rate of change for those factors as well as the ability to predict these changes. In accordance with previous literature, we use product complexity to represent the first dimension and technological uncertainty, demand uncertainty, and supply uncertainty to capture the dimension of dynamism (Premkumar et al. 2005). These factors reflect the dimensions of EU and have been regarded as being most relevant to supply chain contexts and the information processing needs of organizations (Bensaou and Anderson 1999; Bensaou and Venkatraman 1996; Chen and Paulraj 2004; Davis 1993; Fynes et al. 2004; Heide and John 1990; Premkumar et al. 2005).

*Technological uncertainty* is defined as the extent of technological changes evident within an industry (Chen and Paulraj 2004). It refers to the technical level of future product and process changes as well as the inability to accurately forecast the technical or design requirements for the product (Fynes et al. 2004; Premkumar et al. 2005). *Demand uncertainty* reflects changes in demand for the processed product and the inability to accurately predict these fluctuations, which may result in forecast errors (Premkumar et al. 2005; Walker and Weber 1987). These forecast errors are influenced by unknown or unpredictable variations in both the quantity and timing of demand that is experienced in a supply chain (Fynes et al. 2004). *Supply uncertainty* is similar to demand uncertainty, in that it is also related to the unpredictability of quantity and timing (Fynes et al. 2004). However, in contrast to demand uncertainty, it represents the dynamisms in supply in terms of availability, stability, and consistency in quality that influence timeliness and inspection requirements (Chen and Paulraj 2004; Premkumar et al. 2005). *Product complexity* also contributes to uncertainty in supply chains (Premkumar et al. 2005) and is defined as the degree of customizability, intricacy, and variety (Sancha et al. 2014). It also refers to the nature of the product in terms of the diversity of inputs as well as the adjustments required from suppliers (Wong et al. 2012).

According to OIPT, organizations typically have two strategies for coping with EU and the resulting increased information needs: First, developing buffers in order to reduce the effect of uncertainty (increase slack) and, second, increasing adaptability by implementing structural mechanisms, which provide real-time, accurate, and relevant information to reduce uncertainty (Grover and Saeed 2007). An example of the latter is the implementation of advanced information processing capabilities through integrated IS. These IS enhance the flow of information and facilitate collaboration among organizations within the supply chain

(Huang and Pan 2014; Premkumar et al. 2005; Wang et al. 2013), which is reflected in our conceptualization of IT-enabled collaboration described below.

### 1.2.2 IT-enabled collaboration as an information processing capability

Based on the resource-based view, IT value researchers argue that IT resources per se – such as software, hardware, and IT personnel – do not lead to value, because they are imitable and mobile. Instead, firms should develop unique capabilities for implementing and using IT resources in combination with other organizational resources. By doing so, these IT capabilities are rendered organizationally embedded and not easy transferable, thereby leading to business value (Bharadwaj 2000; Ray et al. 2005; Wade and Hulland 2004). Extended to interorganizational relationships, IT capabilities refer to the use of interorganizational IS (IOS) in combination with other resources to perform interorganizational business activities and processes (Rai et al. 2006). Information processing capability describes the ability to gather, interpret, and synthesize information properly in order to deal with uncertainties (Huang and Pan 2014; Tushman and Nadler 1978). This capability can be enabled by IT, as integrated IOS allow for the exchange of high quality information, more efficient information processing, and enhanced absorptive capacity (Malhotra et al. 2005; Roberts and Grover 2012).

In this study, we investigated an interorganizational information processing capability that has garnered much attention in research: IT-enabled collaboration. This capability is defined as business-to-business activities – such as information, decision, resource, and process sharing – that are facilitated by IT (Johnson and Whang 2002). Literature has examined IT-enabled collaboration both on a general level as well as more specifically. Various studies have investigated particular tools, such as supply chain collaboration systems (Hadaya and Cassivi 2012), and dimensions, e.g., IT-enabled integration (Rai et al. 2006) and information sharing (Barua et al. 2004). We chose IT-enabled collaboration to investigate the role of uncertainties in value co-creation for several reasons: First, as a generic and comprehensive capability, it encompasses a majority of IT-enabled business-to-business activities. Second, previous studies have shown that IT-enabled collaboration influences firm and SCP both directly (Ko et al. 2009; Rosenzweig 2009) and indirectly through intermediate factors, such as interorganizational learning (Choi and Ko 2012). Third, it has already been introduced as a suitable capability for investigating the role of contextual factors (Chan et al. 2012; Chong et al. 2009; Rosenzweig 2009).

## 1.3 Research Model and Hypotheses

In accordance with previous research and OIPT, the study's research model (Figure B-6) is based on the following theoretical underpinnings. The first basis is the assumption that IT-enabled collaboration as an information processing capability facilitates interorganizational information sharing and integration with supply chain partners, thus enhancing performance (Choi and Ko 2012; Malhotra et al. 2005; Wang et al. 2006). Second, as OIPT argues that high uncertainty increases information processing needs, which must be matched by expanding information processing capabilities (Galbraith 1973), the model assumes that the relationship between IT-enabled collaboration and SCP is moderated by the degree of EU.

Drawing on the moderation perspective of fit (Venkatraman 1989), in the following sections we develop the theoretical model that guides our study and derive our hypotheses in order to explain the moderating effects of EU on the proposed relationship between IT-enabled collaboration and SCP.

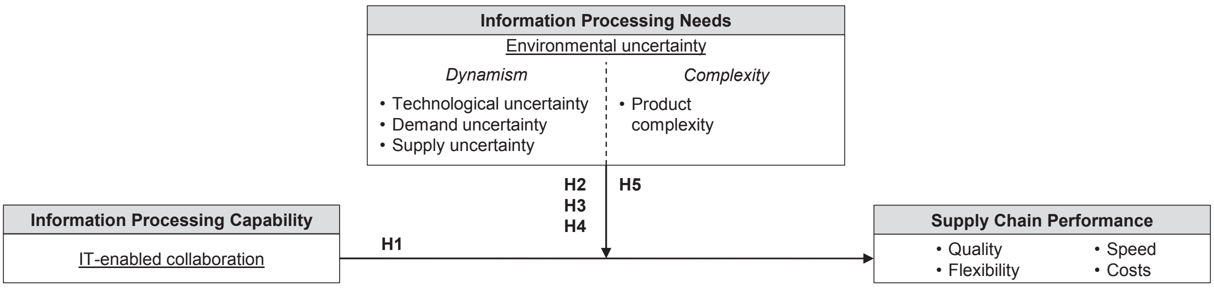


*Figure B-6. Research model*

### 1.3.1 Linking IT-enabled collaboration and supply chain performance

According to the prevailing literature, IT-enabled collaboration that leverages interorganizational IS leads to value through both a better exchange of information and communication as well as an improved coordination with partners along the supply chain. The standardized exchange of information and communication among partnering organizations with compatible IS (Koufteros et al. 2005) reduces technical barriers and facilitates seamless information flows. This IT-enabled collaboration enables organizations to deal with large amounts of data (Barua et al. 2004; Wong et al. 2015), resulting in improved visibility of information within the supply chain (Barua et al. 2004; Choi and Ko 2012; Roberts and Grover 2012; Wong et al. 2015). Going beyond the improved flow of information, this boundary-spanning mechanism also establishes a common platform for coordinating operations among partners in a supply chain that require inputs and developmental efforts from various partners

(Galbraith 1973), such as production planning, product design and development, or distribution network design. These joint organizational efforts reduce the chance for organizations to make conflicting decisions (Premkumar 2000; Wong et al. 2015). Hence, IT-enabled collaboration empowers organizations within a supply chain to work together more efficiently and effectively than their less integrated counterparts (Rosenzweig 2009) in terms of cost reductions, process speed and quality improvements, as well as increased flexibility (Johnson and Whang 2002; Rosenzweig 2009; Wang et al. 2013). As a result, organizations engaged in IT-enabled collaboration are able to enhance both operational SCP in the short run as well as strategic benefits in the long run (Choi and Ko 2012; Mukhopadhyay and Kekre 2002). Therefore, and in accordance with prevailing research, we submit the following hypothesis:

*Hypothesis 1: IT-enabled collaboration is positively related to supply chain performance.*

### 1.3.2 IT-enabled collaboration and supply chain performance in context

Now, the salient question arises of whether the proposed positive relationship in Hypothesis 1 is influenced by certain contextual factors. In this study, we therefore consider the various dimensions of EU to moderate the specific relationship between IT-enabled collaboration and SCP. Accordingly, the focus of this study lies on the strength of the moderation effect. Thus, the aim is to examine the impact of EU on the proposed relationship (Hypothesis 1), but we do not particularly focus on the joint effect of IT-enabled collaboration and EU on performance outcomes, drawing instead on the moderation perspective of fit (Venkatraman 1989).

According to OIPT, there is a need to improve information processing capabilities under high uncertainty (Galbraith 1973). Indeed, EU demands organizations to acquire and process additional, rich information (Koufteros et al. 2005; Wong et al. 2011), which requires that external integrative mechanisms be used to collect information (Galbraith 1973), coordinate and monitor the business activities of partnering organizations (Miller 1992), and facilitate flexible responses as well as rapid decision making (Sitkin and Sutcliffe 1994; Wong et al. 2011). Therefore, we argue that the proposed positive relationship between IT-enabled collaboration and SCP is strengthened under high levels of EU, as the fit between information needs and information processing capability results in improved performance (Premkumar et al. 2005). In the following, we reflect on this general assumption and discuss the moderating effect for each dimension of EU considered in greater detail.

**Technological uncertainty**, or the rate of technological change, substantially influences governance structures of transactions between organizations (Heide and John 1990; Walker and

Weber 1987). Frequent improvements or changes in product functionalities, manufacturing processes, and shifts in the design of components create significant information needs for partnering organizations (Premkumar et al. 2005), as they often rely on emerging technologies that require clarification and assistance during diffusion (Fynes et al. 2004). As a result, organizations are expected to process information more frequently with partners in the supply chain in order to enhance knowledge about new technologies and capabilities (Premkumar et al. 2005). Hence, when technology is changing rapidly, organizations must be able to collaborate more flexibly and share information more quickly than when technology is more predictable (Fynes et al. 2004). Accordingly, IT-enabled collaboration is expected to be more valuable for SCP when technological uncertainty is high. Therefore, we propose a second hypothesis:

*Hypothesis 2: Technological uncertainty strengthens the relationship between IT-enabled collaboration and supply chain performance.*

**Demand uncertainty** creates adaptation problems between organizations within a supply chain and significantly increases requirements for coordination mechanisms (Grover and Saeed 2007; Heide 1994; Walker and Weber 1984). Under conditions of high demand uncertainty, organizations must monitor forecasts continuously and are forced to perform adjustments accordingly in order to predict fluctuations and effectively respond to deviations (Walker and Weber 1987). As a result, organizations require timely information and tighter information linkages with partnering organizations to communicate the frequent changes (Premkumar et al. 2005). In contrast, forecast errors and deviations from estimates are likely to be fewer for organizations operating under stable demand, where customer needs and preferences do not change frequently, resulting in less benefit from mutual adjustment processes (Fynes et al. 2004). As the primary strategy for reducing demand uncertainty is the timely availability of relevant information (Grover and Saeed 2007), organizations operating in volatile demand environments are more likely to benefit from expanded information processing capabilities that provide structured and near-real-time information to supply chain partners (Premkumar et al. 2005). Accordingly, we argue that IT-enabled collaboration has a greater contribution to SCP when demand uncertainty is high.

*Hypothesis 3: Demand uncertainty strengthens the relationship between IT-enabled collaboration and supply chain performance.*

**Supply uncertainty** is similar to demand uncertainty in that it relates to the unpredictability of the quantity and timing of supply. Significant dynamism in supply can generate risk in supply chain processes (Cannon and Perreault 1999; Premkumar et al. 2005), such as manufacturing downtime, quality and yield problems, order-entry errors, forecast inaccuracies, or logistical malfunctioning (Fynes et al. 2004; Walker and Weber 1987). Therefore, under such conditions, organizations require more information for flexible and timely decision making (Premkumar et al. 2005). The exchange of information along the supply chain as well as close collaboration and coordination via electronic linkages with partnering organizations have been found to be highly effective in reducing the risk of supplier failure and supply uncertainties (Lee 2002). Hence, as with demand uncertainty, organizations operating in volatile supply environments are likely to benefit more from IT-enabled information processing capabilities than those operating in stable supply environments (Fynes et al. 2004). Therefore, we propose the following hypothesis:

*Hypothesis 4: Supply uncertainty strengthens the relationship between IT-enabled collaboration and supply chain performance.*

**Product complexities**, which reflect the final factor of EU, are said to contribute to uncertainty in a transaction (Malone et al. 1987; Premkumar et al. 2005). A complex and customized product without standard specification requires greater interaction and information sharing with partnering organizations as well as joint actions in the design and manufacturing process (Premkumar et al. 2005). As a result, complex products typically call for the exchange of rich, product-related information across multiple functional areas of supply chain partners (Novak and Eppinger 2001; Rosenzweig 2009). In the presence of these factors, close and collaborative relationships are needed and organizations prefer tightly integrated supply chains to facilitate the flow of information via electronic linkages (Bensaou and Anderson 1999; Brown and Eisenhardt 1995; Wong et al. 2012). In contrast, when products are low in complexity, the value of IT-enabled collaborative relationships is likely to be diminished for SCP outcomes, as minimal information exchange is required (Wong et al. 2012). In such a case, interorganizational coordination within the supply chain can instead be accomplished by simple procedures and preplanning. Accordingly, we propose a fifth hypothesis:

*Hypothesis 5: Product complexity strengthens the relationship between IT-enabled collaboration and supply chain performance.*

## 1.4 Research Design

### 1.4.1 Measurement of constructs

All scales for both the dependent and independent variables were adopted from validated measures used in prior and corresponding research and were translated into German. The results were independently cross-checked by two researchers and discrepancies were discussed until a common understanding was reached. An overview of all measurement instruments including both items and original authors can be found the Appendix. Previous research has suggested that SCP is a multidimensional construct; therefore, to capture its broad scope, SCP is modeled as a second-order construct reflecting four first-order dimensions, namely quality, speed, cost, and flexibility (Chen et al. 2013; Hult et al. 2006). The operationalization of the independent variables also follows the original scales from corresponding research and are as follows: IT-enabled collaboration, product complexity, technological uncertainty, supply uncertainty, and demand uncertainty. In accordance with prior literature, all independent variables were modeled as reflective constructs and items were measured using a seven-point Likert scale, except for one: the product complexity construct is suggested to be measured with a single-item scale that ranges from the manufacture of standardized products to customized products (Rosenzweig 2009; Saeed et al. 2005). The scale for IT-enabled collaboration was adapted from Chan et al. (2012). In line with previous research, we measured this capability by the actual use of IOS in major domains of supply chain collaboration (Rai et al. 2012; Subramani 2004). Furthermore, as firm size plays a critical role in the use and integration of interorganizational IS in supply chains (Zhu and Kraemer 2005) – larger firms tend to enjoy scale efficiencies and are equipped with more resources (Wong et al. 2012) – we included this measure as a control variable in terms of the number of employees.

### 1.4.2 Sample and non-responses

To test the theoretical model, data was collected between July and September 2015 from organizations in the German wood industry, which is Europe's second largest in terms of production value. Furthermore, the wood industry is one of the most significant sectors in Germany, accounting for the largest share of employees and the second largest annual turnover. The wood industry was chosen as the unit of analysis for three interrelated reasons: First, this industry exhibits a low to medium rate of IS diffusion in general (Arano and Spong 2012; Karuranga et al. 2005; Vlosky and Smith 2003). Therefore, compared to more mature industries, we expect to see a higher degree of variance in IT-enabled collaboration. Second, despite the relatively limited diffusion of IS, previous studies have demonstrated the importance of technological integration through IS for the wood industry (Trang et al. 2014; Zander et al. 2015b). Third, the processing and utilization of renewable resources, such as wood, is typically characterized by a high level of complexity and EU regarding quantity, quality, and the time of availability (Narodoslawsky et al. 2008; Zander et al. 2015a). Thus, both the internal and external contextual factors considered in this study are highly relevant in this industry context. Given the low diffusion of IS and its potential benefits – particularly against the background of the existing EU – we argue that the wood industry is a suitable starting point for analyzing the conditions under which IT-enabled collaboration contributes to better SCP.

Respondents were gathered from the *Fordaq* database using an online survey method. *Fordaq* is a sector-specific network that provides a business database with contact information, specialized in the forestry and wood cluster and. Personalized survey invitations were distributed among organizations involved in woodworking, wood processing, wood building, or the timber trade. A total of 203 questionnaires were returned, leading to an overall response rate of just below 10 %. However, of these cases, 53 were excluded due to quality criteria, such as missing values or implausibility of firm characteristics and IT usage behaviors. Hence, a final sample of 150 complete cases that fulfilled all quality criteria remained. The sample characteristics are summarized in Table B-29.

*Table B-29. Sample characteristics*

| **Industry sub-sector** | | **Respondent's title** | | |
|---|---|---|---|---|
| Woodworking industry | 32.9% | CEO | 38.8% | |
| Wood processing industry | 28.8% | Senior IT manager | 12.7% | |
| Wood building industry | 13.0% | Senior manager | 48.5% | |
| Timber trade | 16.4% | *Purchasing & supply* | | 10.6% |
| Other | 8.9% | *Production & logistics* | | 24.4% |
| **Number of employees** | | *Marketing & sales* | | 13.5% |
| Small (<50) | 50.6% | | | |
| Medium (50–250) | 32.7% | | | |
| Large (>250) | 16.7% | | | *N=150* |

Low response rates are typical for this kind of web-based survey (Preston and Karahanna 2009); however, they bear the risk of non-response. To account for this threat, we used two common measures: First, the sample characteristics are similar to those of the basic population, indicating that our sample is fairly representative. Second, we checked for mean differences between the construct items in the first and the second halves of the sample (Armstrong and Overton 1977); the results of the t-tests revealed no significant differences ($p < .10$). Both indicate that non-responses are not a major threat for this study.

## 1.5 Data Analysis and Results

To test the proposed model and hypotheses, we used a structural equation modeling (SEM) approach. We decided to apply the partial least squares method (PLS) for two reasons: First, it has fewer demands for sample size and excels at prediction. Second, a normal distribution is not required (Ringle et al. 2012). The analysis was supported primarily using the software SmartPLS 2.0. In addition, SPSS Statistics 21 was used for tests that are unavailable within the SmartPLS package. The data analysis follows the widely adopted two-step analytic approach for SEM (Anderson and Gerbing 1988). First, the quality of the measurement model should be assessed to ensure validity and reliability. Then, the structural model can be analyzed.

### 1.5.1 Measurement model assessment

According to Chin (1998), the sample size should exceed 10 times the number of indicators for the scale with the largest number of indicators. In addition, the sample size must be greater than 10 times the number of paths directed to any latent variable in the model. Our sample size, which includes 150 cases, meets both criteria.

A single informant assessed both the independent and dependent variables in our study. As a result, common method variance (CMV) poses a potential threat to the validity of the results (Podsakoff et al. 2003). Therefore, following the approach of Podsakoff et al. (2003), we checked for CMV with Harman's single factor test and ran an exploratory factor analysis. The results reveal that no single factor emerges from the data and that a general factor does not account for the majority of the covariance among the measures. Hence, CMV is not a major concern for this study.

*Table B-30. FL, CR, AVE, and inter-construct correlations*

| Construct | FL | AVE | CR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. IT-enabled collab. | .788–.863 | 0.876 | .935 | **.936** | | | | | | | | |
| 2. Product complexity | n/a | n/a | n/a | .746 | **n/a** | | | | | | | |
| 3. Tech. uncertainty | .870–.933 | 0.820 | .870 | .836 | .859 | **.906** | | | | | | |
| 4. Demand uncertainty | .875–.940 | 0.837 | .863 | .826 | .851 | .750 | **.915** | | | | | |
| 5. Supply uncertainty | .887–.931 | 0.828 | .951 | .811 | .832 | .859 | .785 | **.910** | | | | |
| 6. Quality | .877–.894 | 0.790 | .938 | .557 | .233 | .382 | .375 | .398 | **.889** | | | |
| 7. Cost | .807–.861 | 0.795 | .723 | .442 | .086 | .266 | .291 | .255 | .831 | **.892** | | |
| 8. Speed | .840–.876 | 0.751 | .938 | .303 | -.049 | .114 | .134 | .116 | .696 | .860 | **.867** | |
| 9. Flexibility | .844–.901 | 0.913 | .939 | .387 | .016 | .180 | .204 | .190 | .784 | .886 | .817 | **.955** |

*Note: FL: Factor loadings; AVE: average variance extracted; CR: composite reliability; Bolded numbers: square root of AVE; Note: FL, AVE, and CR cannot be computed for formative or single item measures.*

To assess the fit of the proposed hypotheses and empirical data, the measurement model was tested for content, convergent, and discriminant validity. We assured content validity by using established theories and existing scales from related research. Three measures were evaluated to offer evidence of convergent validity: individual item reliability, composite construct reliability (CR), and average variance extracted (AVE). Due to low factor loadings, one item each from IT-enabled collaboration and quality scale were dropped (see Appendix). Afterwards, as depicted in Table B-30, all items loaded on their assigned construct at .70 or above, which indicates an acceptable limit of item reliability (Gefen and Straub 2005). The CR ranges between .723 and .951, which is also above the acceptable limit of .70 (Hulland 1999). Furthermore, the AVEs for all constructs exceed the minimum threshold of .50 (Bhattacherjee and Premkumar 2004). The AVE is also used to evaluate discriminant validity (Chin 1998; Fornell and Larcker 1981); as the AVE for each construct is greater than the variance shared with other constructs (square root of AVEs on the diagonal in Table B-30), the distinctiveness of constructs – and thus discriminant validity – can be confirmed. Finally, we checked the cross-loadings. As expected, all items display higher loadings on their assigned constructs than on any other construct within the model (Chin 1998). Hence, our analysis suggests that our model is both acceptable and reliable.

### 1.5.2 Structural model assessment

To evaluate the structural model and test our hypotheses, we used a bootstrapping re-sampling procedure (5000 samples) to compute inference statistics, as is the preferred method when the sample size is greater than 100 (Kock 2011). The central criterion for the assessment of the PLS structural model is the explained variance of the endogenous variable. With an explained variance of .560, this value lies at a satisfactory level. However, the explained variance is typically highly dependent on the research context (Hair et al. 2011). Therefore, we also computed the Stone-Geisser $Q^2$ coefficient with a blindfolding procedure to determine the predictive relevance of the structural model. With a value of .393, this measure clearly exceeds the minimum threshold of 0 (Hair et al. 2011).

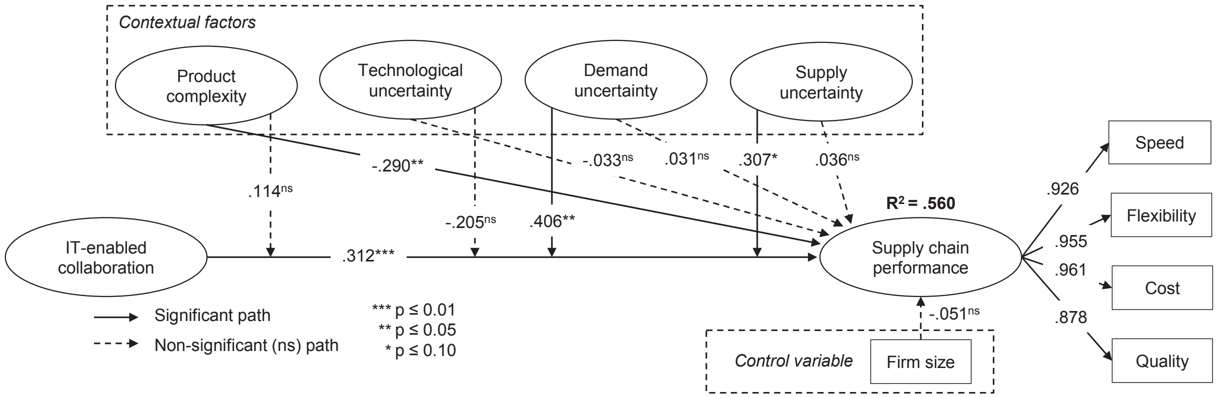


*Figure B-7. PLS results of the structural model*

The estimates of the path coefficients as well as the significance levels of the bootstrapping procedure for both direct and moderating effects are presented in Figure B-7. The structural model indicates that IT-enabled collaboration positively and significantly (b = .312; $p \leq .01$) influences SCP, providing strong support for Hypothesis 1. With regard to the contextual factors considered in our model, which were proposed to influence the relationship between IT-enabled collaboration and SCP, the results offer support for two of the four remaining hypotheses. The analysis demonstrates that both demand uncertainty (b = .406; $p \leq .05$) and supply uncertainty (b = .307; $p \leq .10$) positively influence this relationship, offering support for Hypothesis 3 and 4. However, we found no empirical support for Hypothesis 5, as the level of product complexity was revealed not to influence the relationship between IT-enabled collaboration and SCP. That is, the interaction effect of IT-enabled collaboration and product complexity in SCP is not statistically significant (b = .114; $p \geq .10$). Turning to technological uncertainties, the results also do not support Hypothesis 2: The level of technological uncertainty does not moderate the relationship between IT-enabled collaboration and SCP. In contrast to our theoretical assumption, the results display a negative effect (b = -.205). However, this relation cannot be shown to be empirically significant ($p \geq .10$). Lastly, we found no significant effect of the control variable (b = -.051; $p \geq .10$).

## 1.6 Discussion

### 1.6.1 Summary of findings

The results of the analysis regarding the relationship between IT-enabled collaboration and performance (H1) support our expectation and highlight the value of developing information processing capabilities for partnering organizations within a supply chain. Based upon survey data gathered from 150 supply chain executives and senior managers, the empirical analysis suggests that IT-enabled collaboration is key for achieving greater SCP in terms of speed, flexibility, cost, and quality. These findings are largely consistent with prior research on IT value co-creation (e.g., Chen et al. 2013; Lee et al. 2014; Rajaguru and Matanda 2013). However, by drawing on the OIPT, our analysis goes one step further and examines how this relationship is influenced by several contextual factors arising from different dimensions of EU. In particular, we observe that both demand uncertainty (H3) and supply uncertainty (H4) strengthen the relationship between IT-enabled collaboration and SCP. Hence, consistent with our argumentation and the information processing view of the firm, organizations operating in environments with volatile supply and demand benefit particularly from IT-enabled information processing capabilities, as they enable organizations to respond to changing conditions in a flexible and timely manner. These findings are generally in line with previous research on the contextual role of volatile supply and demand (e.g., Fynes et al. 2004). However, the results are also in contrast to findings from related research on the contingent effects of EU. For example, both Koufteros et al. (2005) as well as Wong et al. (2011) report insignificant moderating effects of EU. Furthermore, Wong et al. (2012) find that the positive association between information integration and performance is strengthened when the firm experiences a low level of EU. However, the comparability of results from the studies mentioned above is limited because they only consider EU as a unidimensional construct.

In terms of technological uncertainty, the empirical analysis does not offer support for Hypothesis 2. Instead, the results suggest a negative moderating effect of technological uncertainty on the relationship between IT-enabled collaboration and SCP. However, this relation cannot be shown to be empirically significant. In fact, there is conflicting empirical evidence regarding the effects of technological uncertainty on organizations' integration decisions (Walker and Weber 1987). According to Fynes et al. (2004) and Krause (1999), a possible explanation is that organizations prefer to keep technology in-house, where it represents a competitive advantage. This is particularly true for the wood industry, where the sharing of information and knowledge is often restricted to non-core and non-sensitive activities (Zander et al. 2015a). Furthermore, small organizations, which account for the largest share in our sample, tend to be less innovative than their larger counterparts, resulting in lower levels of technological change and uncertainty in general (Wagner and Hansen 2005).

Finally, the analysis demonstrates that the relationship between IT-enabled collaboration and SCP is not significantly influenced by the level of product complexity and thus offers no support for Hypothesis 5. Simultaneously, the results indicate that product complexity significantly and negatively impacts SCP, emphasizing the relevance of this factor. However, these results are consistent with findings from previous research. According to Rosenzweig (2009), a potential explanation for this is that under certain conditions, IT-enabled collaboration can be beneficial across varying degrees of product complexity: For complex products, it enables the exchange of rich, product-related information and facilitates the flow of information via electronic linkages. In contrast, when products are low in complexity and subject to high volumes, properly executed IT-enabled collaboration can still be worthwhile, as it allows for close collaboration with key customers and the optimization of product flows across the supply chain.

### 1.6.2 Implications and contributions

The study incorporates contextual factors with regard to the impact of IT investments on performance outcomes and sets out to offer insights on the question regarding the conditions under which IT creates value in the context of supply chains. By drawing on the information processing view of the firm, our study findings offer valuable contributions and implications to both research and practice.

The first theoretical contribution concerns the conceptualization of constructs. The study demonstrates that EU should not be seen as a single, unidimensional construct reflecting various dimensions simultaneously; instead, our results indicate that these dimensions are empirically distinct from one another. Unlike previous studies that conceptualize EU as a unidimensional construct, our approach allows for comprehensive model development and a deeper understanding of the moderating role of the various dimensions of EU. Moreover, this approach may have the potential to resolve the contradicting results from previous research. Second, the study is one of the few in research on IT value that draws on the OIPT and applies the moderation perspective of fit in terms of moderated regression analysis to examine the role of contextual factors. Despite some divergences, our results support the basic structure of the theoretical model, highlighting both the applicability as well as the merits of OIPT as a theoretical lens for research on IT value in general and research on IT value co-creation in particular. Third, by drawing on OIPT and considering different dimensions of EU as inherent conditions of interaction in supply chains, the study directly responds to calls for both more theory-driven empirical research on supply chain management (Chen et al. 2013) and investigating the role of contextual factors with regard to the relationship between IT-related investments and performance (Schryen 2013).

Although this study focuses on a specific industrial sector, our results are largely consistent with theory and may to some extent be generalizable to other sectors, as environmental uncertainty is an important factor in supply chains across various domains. Hence, in terms of practical implications, this study provides important recommendations for supply chain executives and IT managers. First, the findings highlight that developing efficient information processing capabilities is crucial for mitigating uncertainty in supply chains. In particular, organizations should consider investing in information processing capabilities when operating under volatile conditions of demand and supply. Second, as a result of the former, our findings demonstrate that contextual factors are highly related to performance outcomes of IT-enabled collaboration. Therefore, managers should carefully reflect upon the conditions of their business environments before investing in the development and implementation of IT-related capabilities. Third, practitioners can profit from our study, as it equips managers with both theoretical background and empirical evidence relating to why investments in IT may not necessarily reap the expected performance outcomes. Lastly, our study provides a useful tool for measuring contextual factors, which managers can apply to diagnose the conditions of their business environment.

### 1.6.3 Limitations and future research

We acknowledge that there are several limitations of the study, which can be remedied by extending our work in a number of directions. First, although our findings offer support for our theoretical assumptions, a portion of the variance remains unexplained, as is the case for most empirical studies. Therefore, future research might consider incorporating further determinants and moderating factors. For example, despite EU being a key factor affecting the performance of operations, it is not the only contingency factor. There are also likely to be means of mitigating uncertainties in supply chains other than IT-enabled collaboration. Second, while we argue that the wood industry is a suitable starting point for analyzing contextual factors, this specific context makes it harder to generalize, as the strength of factors may vary due to industry-specific requirements and processes. Although the survey of a single industry has its advantages, future studies should investigate industries with different characteristics in order to improve generalizability. Third, the unit of analysis of this study is the supply chain of an organization and its primary products, allowing for the consideration of supply chain–wide patterns. However, it would be worthwhile to examine the role of contextual factors and their influence on IT value at different stages of a supply chain in order to clarify the role of varying operational procedures. Fourth, this study does not consider that the different dimensions of EU might influence each other. For example, product complexity is often associated with high levels of demand uncertainty (Rosenzweig 2009). Although the analysis supports our conceptualization of constructs and suggests that the various dimensions of EU are empirically distinct from one another, the inter-construct correlations indicate that these dimensions are interrelated, which might have influenced our results. Therefore, future research should proceed by examining these interactions and their influence on the relationships between IT investments and performance in greater detail. For example, considering and analyzing EU as a multidimensional hierarchical construct could enhance our understanding of how the different dimensions of EU are related to one another as well as how and under what circumstances this affects the relationship between IT investments and performance outcomes. Fifth, we used a single informant approach and captured self-reported perceptions of the dependent and independent variables. Although this is common in IS research (e.g., Saraf et al. 2007), the findings are nonetheless susceptible to the effects of CMV. While the results from Harman's single-factor test suggest that CMV is not significantly present in our data, we encourage future research to collect objective performance indicators and data from multiple sources and informants across the supply chain. Lastly, there is a threat in using measures of IT capabilities and IT success collected at a single point in time, as effects may be time shifted. Therefore, future studies should take the opportunity to substantiate findings using longitudinal data.

## 1.7 Conclusion

Our study advances the knowledge frontier of IT value research and contributes to the nascent stream that incorporates contextual factors with regard to the impact of IT investments on performance outcomes. By drawing on OIPT, the study sheds light on the salient question of the conditions under which IT creates value in the context of supply chains and offers an explanation for the mixed results in previous literature. Based on our empirical findings, we provide academics and managers with insights into the contextual role of EU and provide guidance for both research and practice.

## 1.8 Appendix

*Table B-31. Operationalization of the measurement scales*

| Construct | Scale |
|---|---|
| **IT-enabled Collaboration** (Chan et al. 2012) | (Please rate how frequently you use the following IT tools in your supply chain): 1. Direct procurement tools. 2. Replenishment tools. 3. Projected shortages tool. 4. Delivery and tracking tool. 5. Design tool 6. Supply chain planning forecasting tool. 7. Capacity planning tool 8. Business strategy tool.* |
| **Product Complexity** (Rosenzweig 2009) | (Please select one category below that best describes the degree of customization for the primary products manufactured in your organization) 1. Mostly standard products with no options. 2. Mostly standard products with standard options. 3. Mostly standard products modified to customer specifications. 4. Mostly standard products with options modified to customer specifications. 5. Mostly customized products manufactured to customer specifications. |
| **Technological Uncertainty** (Fink et al. 2007) (Chen and Paulraj 2004) | 1. There is a high probability of product improvements in the next two years. 2. We are often able to predict the nature of product improvements. 3. There have been many changes in the product over the past five years 4. Our industry is characterized by rapidly changing technology. 5. If we don't keep up with changes in technology, it will be difficult for us to remain competitive. 6. The rate of process obsolescence is high in our industry. 7. The production technology changes frequently and sufficiently. |
| **Supply Uncertainty** (Chen and Paulraj 2004) | 1. The suppliers consistently meet our requirements. 2. The suppliers produce materials with consistent quality. 3. We have extensive inspections of incoming critical materials from suppliers. 4. We have a high rejection rate of incoming critical materials from suppliers. |
| **Demand Uncertainty** (Chen and Paulraj 2004) | 1. Our master production schedule has a high percentage of variation in demand. 2. Our demand fluctuates drastically from week to week. 3. Our supply requirements vary drastically from week to week. 4. We keep weeks of inventory of the critical material to meet the changing demand. 5. The volume and/or composition of demand are difficult to predict. |
| **Supply Chain Performance** (Hult et al. 2006) (Chen et al. 2013) | **Quality:** 1. The quality of the order fulfillment process is getting better every time. 2. We have recently seen an improvement in the quality of the order fulfillment process.* 3. We are satisfied with the quality of the order fulfillment process. 4. Based on our knowledge of the order fulfillment process, we think it is of high quality. 5. The quality of the order fulfillment process could not be much better than it is today. **Speed:** 1. The length of the order fulfillment process is getting shorter every time. 2. We have recently seen an improvement in the cycle time of the order fulfillment process. 3. We are satisfied with the speed of the order fulfillment process. 4. Based on our knowledge of the order fulfillment process, we think it is short and efficient. 5. The length of the order fulfillment process could not be much shorter than it is today. **Cost:** 1. The cost associated with the order fulfillment process is getting better every time. 2. We have recently seen an improvement in the cost associated with the order fulfillment process. 3. We are satisfied with the cost associated with the order fulfillment process. 4. Based on our knowledge of the order fulfillment process, we think it is cost efficient. 5. The cost associated with the order fulfillment process could not be much better than it is today. **Flexibility:** 1. The flexibility of the order fulfillment process is getting better every time. 2. We have recently seen an improvement in the flexibility of the order fulfillment process. 3. We are satisfied with the flexibility of the order fulfillment process. 4. Based on our knowledge of the order fulfillment process, we think it is flexible. 5. The flexibility of the order fulfillment process could not be much better than it is today. |

*Note: * Item has been removed due to low factor loadings.*

# 2 Study #6: Creating Value through IT-Enabled Resource Efficient Production

*Table B-32. Fact sheet of Study #6*

| | |
|---|---|
| Title | Creating Value through IT-Enabled Resource Efficient Production: A Dynamic Capability Perspective |
| Authors | Markus Mandrella, mmandre@uni-goettingen.de* <br> Sebastian Zander, szander1@uni-goettingen.de* <br> Lutz M. Kolbe, lkolbe@uni-goettingen.de* <br><br> *Georg-August-Universität Göttingen <br> Chair of Information Management <br> Platz der Göttinger Sieben 5 <br> 37073 Göttingen |
| Outlet | Proceedings of the Pacific Asia Conference on Information Systems (PACIS) 2017, Completed Research Paper |
| Abstract | The efficient use of resources in production has been a crucial strategy for achieving performance in manufacturing firms for decades. Information technology has become an important enabler in manufacturing firms, having the potential to transform the industry into a more resource efficient one with sustainable behaviour. However, its influence on resource efficient production remains unexplored. By drawing on the resource-based view and the dynamic capability theory, we develop a research model and propose that IT alignment is the primary source of resource efficient production, which leads to superior performance outcomes. Moreover, we argue that IT alignment mediates the relationship between IT integration and resource efficiency. An empirical study across executives in manufacturing firms (n = 242) was conducted to empirically validate the research model. Our findings provide evidence for the important role of IT capabilities for resource efficient production and advance our understanding of creating IT value in manufacturing contexts. |
| Keywords | IT business value; Resource efficiency; Dynamic capabilities; IT alignment; IT integration |

## 2.1 Introduction

Resource efficiency, which refers to the minimization of the amount of resources to achieve a given level of output (Duflou et al. 2012), has been recognized as important strategy to achieve significant cost savings and superior performance results since the early 1970's (Modi and Mishra 2011). Moreover, the limited availability of natural resources and an increasing awareness for environmental concerns foster the efficient use of resources. This is also highlighted by various international initiatives, for e.g., the European Resource Efficiency Initiative and the United Nations Environment Program (Huysman et al. 2015). This is especially relevant for the manufacturing sector as it plays a vital role in the global economy and consumes a significant amount of renewable and non-renewable materials (Duflou et al. 2012). At the same time, information technology (IT) plays a critical role in the manufacturing industry, having accounted for the highest amount of IT spending across vertical industries in 2014 (Gartner 2015). The role of IT for this industry has changed dramatically since the 1990s, from the automation of transactional processes to that of an enabler of critical business processes (Banker et al. 2006). Therefore, IT is now also seen as important source of transforming manufacturing firms to exhibit a more resource efficient and sustainable behavior (Melville 2010).

The economic impact of IT in manufacturing firms has been examined in IT business value research. It has been demonstrated that IT capabilities can enhance manufacturing performance either directly (e.g., Mishra et al. 2013; Saldanha et al. 2013), or indirectly through intermediate factors such as dynamic manufacturing capabilities (Banker et al. 2006), production capabilities (Ayabakan et al. 2017), and manufacturing's coordination (Bharadwaj et al. 2007). Moreover, the impact of IT on efficient supply chain process capabilities has been shown in various investigations (e.g., Rai et al. 2006; Wang et al. 2013). However, the role of IS for achieving resource efficient production remains unexplored. At the same time, the impact of resource efficiency on firm performance has been discussed for decades in operations research (Adler et al. 2009). Studies found that resource efficiency, including resource efficient production, leads to superior performance impacts for companies (e.g., Browning and Heath 2009; Modi and Mishra 2011; Saldanha et al. 2013). However, no study exists that empirically examines the influence of IT on resource efficient production.

Based on this research gap, we aim to examine how IT contributes to resource efficient production. This seems to be promising in two ways. First, the enabling role of IT in manufacturing has been widely examined in IS research and empirically supported. Hence, a positive impact in the context of resource efficient production, which has been shown to be an important driver of firm performance, can be expected. Second, achieving resource efficiency is challenging for firms, for example, with respect to remaining flexible to environmental changes and avoiding rigidity (Modi and Mishra 2011). Thus, there is also a need and potential of IT to enhance resource efficient production (Melville 2010). We therefore aim to answer the following research questions: (1) Do IT capabilities lead to resource efficient production? (2) What are the underlying mechanisms in the value creation process?

We develop and empirically test a theoretical research model to answer these research questions. Drawing on the resource-based view (RBV) and the dynamic capability theory, we propose IT alignment and IT integration, which have been widely investigated in IT business value research (Gerow et al. 2014; Rai et al. 2006), as possessing capabilities for creating value through resource efficient production. Moreover, we hypothesize that IT alignment as a dynamic capability is the primary source of resource efficient production, thereby mediating the effect of IT integration. A questionnaire-based survey among organizations in the German wood industry was conducted to test the research model. By doing so, we contribute to prior research on business value – especially in the manufacturing context – and operations management.

The rest of the paper is structured as follows: in the next section, we review the concept of resource efficient production and prior research on IT capabilities in the manufacturing context. We then develop the research model and hypotheses. Next, we present the study's research design, followed by the results and analysis of the empirical investigation. Finally, we discuss our research findings and the implications, address the limitations of our study, and offer directions for further research.

## 2.2 Theoretical Background

### 2.2.1 The concept of resource efficient production

Resource efficiency refers to the minimization of the amount of resources to achieve a given level of output (Duflou et al. 2012). Operations management research has conceptualized various aspects of resource efficiency and its impact on financial performance, e.g., inventory (Chen et al. 2005), marketing (Modi and Mishra 2011), and labor (Saldanha et al. 2013) efficiency. In this study, we focus on resource efficient production, referring to the minimization of the amount of resources, i.e. natural, industrial, and waste-as-resources, to transform raw materials into finished products (Huysman et al. 2015; Modi and Mishra 2011). Although resource efficient production targets sustainable issues and can reduce environmental impacts (Delmas and Pekovic 2015) such as reduced gashouse emissions, the focus and ultimate goal lies in the achievement of performance outcomes (Modi and Mishra 2011). It therefore differs from the concept of eco-efficiency, which focuses on the reduction of ecological and environmental impacts (Dahlström and Ekins 2005; Melville 2010).

Operational capabilities in operations management literature are typically conceptualized as multiple-dimensions constructs (Peng et al. 2008). The input-output approach is often applied in extant literature to capture the dimensions of resource efficient production (e.g., Duflou et al. 2012; Modi and Mishra 2011), leading to four underlying dimensions: (1) Input materials, e.g. the use of reusable and defect-free materials (Despeisse et al. 2013), (2) efficient production processes, for example, by minimizing machinery failures and product defects (Daian and Ozarska 2009), (3) output products, e.g. minimizing production residues (Duflou et al. 2012), and (4) efficient logistics processes with suppliers, customers, and other third parties, for example, regarding optimized transportation routes and the minimization of packaging materials (Grant et al. 2010).

### 2.2.2 IT capabilities as sources of manufacturing performance

According to this RBV, firms create business value by developing unique capabilities for combining IT resources with other organizational resources (Bharadwaj 2000; Wade and Hulland 2004). In contrast, IT resources per se, such as software and hardware, are seen as imitable and mobile, therefore not leading directly to value. The dynamic capability theory extends the RBV, defining dynamic capabilities as “the firm’s ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments” (Teece et al. 1997, p. 516). Based on this theory, it is argued that firms need to constantly renew their capaibilities and resources to remain immobile and non-immatable (Teece et al. 1997). Dynamic capabilities are typically characterized as higher-order capabilities that directly lead value, being shaped by lower-order capabilities (Liu et al. 2013). In the context of manufacturing industries, IS scholars have shown that IT capabilities can enhance firm performance either directly (e.g., Mishra et al. 2013; Saldanha et al. 2013) or indirectly through intermediate factors (e.g., Ayabakan et al. 2017; Banker et al. 2006; Rai et al. 2006).

In this study, we investigate two IT capabilities that have garnered much attention in IS research: First, IT integration refers to provision of integrated data and processes through information systems in a focal firm (Bharadwaj et al. 2007). Previous research has recognized IT integration as lower-order capability, shaping the development of higher-order capabilities, such as supply chain integration (Rai et al. 2006), to create business value. Second, IT alignment describes the timely and appropriate fit between business and IT management components to ensure that both remain in harmony (Luftman and Brier 1999). Scholars have conceptualized IT alignment as dynamic capability (Baker et al. 2011; Schwarz et al. 2010) and as an important driver of firm performance (Gerow et al. 2014). As we investigate impacts of IT on operational capabilities, we focus on operational IT alignment, which refers to alignment between business and IT infrastructure and processes to ensure that IT fits the operational requirements of the business (Gerow et al. 2015). Both IT capabilities have been widely used to explain impacts on organizational capabilities in general and in the manufacturing context in particular (e.g., Bharadwaj et al. 2007; Cragg et al. 2002), therefore being suitable for this study.

## 2.3 Research Model

Our conceptual research model, which describes the relationship between IT capabilities, resource efficient production, and operational performance, is shown in Figure B-8. First, in line with previous work in operations management, we place resource efficient production as the ultimate driver of operational performance. Building on prior research in operations strategy literature, we evaluate performance along multiple dimensions, including quality, dependability, cost, and flexibility (e.g., Boyer and Lewis 2002; Ferdows and De Meyer 1990). Second, we build on the RBV and its application in IS research to examine the role of IS in this value creation process. We interpret IT alignment as a dynamic capability and primary source of resource efficient production. Furthermore, we argue that IT integration can be interpreted as lower-order capability and antecedent of IT alignment. Therefore, we propose a mediating effect of IT integration on resource efficient production. As our research focus lies on the role of IT capabilities in enhancing resource efficient production, direct effects between the IT capabilities and operational performance are not considered.

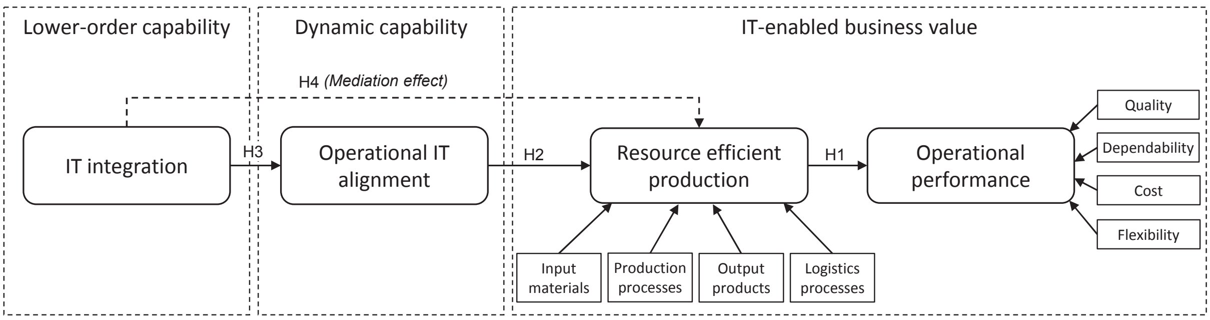


*Figure B-8. Proposed research model*

### 2.3.1 Resource efficient production as source of operational performance

The relationship between resource efficient production processes and firm performance has been widely investigated in literature and is associated with advanced operations management practices (Modi and Mishra 2011). Because such processes are a result of high customization to the specific firm context and path dependencies, they are seen as representative of rare firm capabilities that are difficult to imitate, leading to competitive advantage (Browning and Heath 2009; Peng et al. 2008). Resource efficient production therefore enhances operational performance in manufacturing firms in terms of quality, dependability, costs, and flexibility. Firms that established resource efficient processes minimize the production of waste, leading to cost savings, for example, for procurement as well as inventory and waste management, which can also be invested in other value-adding activities (Delmas and Pekovic 2015; Duflou et al. 2012). Moreover, quality issues and inefficient processes can be detected, which might be overshadowed in the case of a high level of resource slacks (Chase et al. 2006). Therefore, resource efficient production also results in higher dependability due to more predictive and stable production processes (Modi and Mishra 2011). Previous operations management research has shown a positive performance impact of resource efficient production (e.g., Browning and Heath 2009; Modi and Mishra 2011). Therefore, we propose a first hypothesis:

**Hypothesis 1 (H1):** Resource efficient production is positively related to operational performance.

### 2.3.2 The effect of IT capabilities on resource efficient production

In previous research, IT has been shown to enhance advanced manufacturing capabilities and facilitate resource efficient production in the following ways: first, information systems, such as resource planning systems or operational management systems (OMS), help synchronize and automate business processes in manufacturing (Banker et al. 2006). This results in reduced manual tasks of workers, leading to more efficient production processes in terms of higher accuracy and quality regarding the output products (Saldanha et al. 2013). In addition, IS can improve efficiency in production by improving the use and reuse of production assets in multiple plants (Banker et al. 2006). Second, IT can enhance the convergence of information between manufacturing and other functions within firms, such as marketing, product development, and logistics (Bharadwaj 2000; Pavlou and El Sawy 2010). Because of improved coordination between these functions, resources are used more efficiently in accordance with production schedules (Banker et al. 2006). For example, production schedule data may be connected with resource consumption data from facilities management to identify unnecessary production processes, thus leading to the avoidance of resource use (Despeisse et al. 2013). Furthermore, the risk of defective and obsolete products can be minimized, resulting in reduced waste in production (Banker et al. 2006; Mishra et al. 2013). Third, interorganizational systems (IOS) increase the efficiency of supply chains (e.g., Rai et al. 2006), leading to more resource efficient production. IOS improve coordination and information exchange between supply chain partners by reducing communication and order fulfillment errors, therefore leading to more efficient resource allocations (Barua et al. 2004; Mishra et al. 2013). Furthermore, improved coordination leads to more efficient transportation routes and logistics processes by minimizing shipment errors and optimizing packaging (Banker et al. 2006). In addition, knowledge-sharing systems can expose opportunities for the reuse of waste materials in industrial networks in order to enhance resource efficiency (Grant et al. 2010). Lastly, better availability and quality of information improves planning and forecasting in manufacturing, which enhances the efficient use of resources. Information systems, such as OMS, enable the visibility of real-time changes in inventory and demand, leading to the optimization of resource allocations, more efficient use of materials based on material requirements, and reuse of product components (Banker et al. 2006). Moreover, improved information flows create more flexibility regarding decisions for investments in production capacities, thus lowering the need for a high level of additional capacity (Andres and Bedoya 2003).

However, based on the dynamic capability theory, we argue that IT alignment capabilities – rather than the availability of such systems per se – are the primary IT-related source of resource efficient production. First, firms need to make sure that IS are actually used and fit the requirements of the business (Bharadwaj et al. 2007). IT alignment is a capability that ensures this effect by evaluating whether IS supports the business (Gerow et al. 2014; Kearns and Lederer 2004). Hence, firms with advanced operational IT capabilities have implemented IS that are adapted to the complex and unique production processes and well aligned with manufacturing needs (Bharadwaj et al. 2007), leading to value in terms of resource efficient production. Second, manufacturing processes need to remain flexible and adaptive to uncertainties and volatilities in order to avoid unnecessary waste of resources (Modi and Mishra 2011). Moreover, IS used in manufacturing need to be constantly adapted and renewed to correspond to new production processes and technologies (Bharadwaj et al. 2007). Dynamic IT capabilities were shown to enhance a firm's agility and flexibility (Leonhardt et al. 2016) and solve the tradeoff between scale of scope economies by enabling quicker adaptability of products and production processes (Andres and Bedoya 2003). IT alignment is such a capability, as it involves continuous change of a firm's underlying resources and capabilities in order to ensure that IT fits to the business (Baker et al. 2011; Schwarz et al. 2010), thereby faciliating resource efficient production. Based on these arguments, we propose the following hypothesis:

**Hypothesis 2 (H2):** Operational IT alignment is positively related to resource efficient production.

IT integration can be seen as antecedent to operational IT alignment. In IS research, it is widely interpreted as lower-order capability, shaping the development of higher-order dynamic capabilities (e.g., Rai et al. 2006), such as operational IT alignment. Integrated functions of IS, such as consistent data and seamless access to data, enable improved information flow, visibility of business processes, and decision-making (Bharadwaj et al. 2007), leading to improved coordination of activities between and within firms to achieve alignment (Dong et al. 2009). Previous research has shown that general investments in such systems are necessary for achieving IT alignment (Kearns and Lederer 2004; Schwarz et al. 2010). Therefore, an additional hypothesis can be suggested:

**Hypothesis 3 (H3):** IT integration is positively related to operational IT alignment.

Finally, we argue that IT integration does not directly influence resource efficient production, but that this relationship is mediated trough IT alignment. This is theoretically rooted in the application of the RBV in IS research, where lower-order capabilities, such as IT integration, are further away from business value impacts than higher-order dynamic capabilities (Pavlou and El Sawy 2010; Rai et al. 2006). Simply putting in place an integrated IS (such as OMS or ERP) will not influence business value in terms of resource efficient production significantly (Bharadwaj et al. 2007). Moreover, large investments in inappropriate systems can cause rigidity traps and hinder adaptability of production processes (Saldanha et al. 2013). Therefore, we argue that the value of IT integration results from its impact on operational IT alignment and propose a mediation hypothesis:

**Hypothesis 4 (H4):** Operational IT alignment positively mediates the relationship between IT integration and resource efficient production.

## 2.4 Research Design

### 2.4.1 Measures

The scales for operational efficiency, operational IT alignment, and IT integration were adopted from validated measures used in previous studies. All items were measured using multi-item scales with seven-point Likert rating systems. Operational performance was adapted from Wang et al. (2013). Performance should be measured along different dimensions in order to account for tradeoffs between differences in these measures (Banker et al. 2006). Therefore, we used a formative second-order construct, including four different sub-constructs: quality, dependability, cost, and flexibility. For operational IT alignment, a reflective six-item scale was adapted from Gerow et al. (2015). IT integration was measured on an 8-item scale developed by Bharadwaj et al. (2007). An overview of all measurement instruments can be found in the Appendix.

Resource efficient production is primarily assessed with objective measures from secondary databases in previous research (e.g., Ayabakan et al. 2017; Modi and Mishra 2011). However, as perceptual measures are seen to be better suited to the study's context (Chau et al. 2007) and objective measures of resource efficiency are not univocally defined (Huysman et al. 2015), we developed a new construct following the principles of Lewis et al. (2005) and MacKenzie et al. (2011): (1) As the first step, we developed a conceptual model of the construct. A structured literature review has been conducted, resulting in a list of 32 papers for further analysis. Moreover, we conducted 10 expert interviews with managers in the manufacturing industry to identify key attributes of the construct's domain. This content analysis led to the conceptualization of resource efficient production as the extent to which an organization minimizes the amount of resources to transform raw materials into finished products (Duflou et al. 2012; Modi and Mishra 2011), including input materials, production processes, output products, and logistics processes as sub-dimensions (see Background Section). Based on the decision rule by Jarvis et al. (2003), we specified resource efficient production as reflective-formative second-order construct. (2) The second step comprised the development of measures. Based on the results of the literature review and expert interviews, an initial pool of 25 items were derived and grouped into the four dimensions. Items were worded in line with recommendations from literature, such as precise and simple statements (e.g., MacKenzie et al. 2011; Podsakoff et al. 2003). Next, we assessed content validity of the items by utilizing the procedure developed by Lawshe (1975). A group of 13 academic and industry experts were asked to evaluate the relevance of each item to the construct on a 3-points-scale: '1 =

Not relevant', '2= Important (But Not Essential)', '3=Essential'. We calculated the content validity ratio [= ($n$ – $N$/2)/($N$/2)], where $N$ is the sample size and $n$ the number of participants rating the item as 'relevant' or 'important'. As seven items did not exceed the threshold of .54 (Lawshe 1975), they were dropped from the instrument (Lewis et al. 2005). Moreover, items were carefully reworded and optimized according to recommendations of the experts. (3) Finally, we analyzed the measurement properties of the developed construct by conducting a survey in the manufacturing industry in Germany. Following the procedure as described in Lewis et al. (2005), we performed an exploratory assessment of the instrument. The Kaiser-Meyer-Olkin (.89) and Bartlett sphericity test (1.971,24, significant at $p$ = 0.000) ensured sampling adequacy and instrument validity. We computed an exploratory factor analysis using the varimax rotation procedure. Four factors with eigenvalues greater than 1 emerged, accounting for 61.679 % of the variance. All items loaded on their theoretically assigned factor (.52-.81) above the lower bound of .50 (Straub 1989), thereby not loading on multiple factors. Furthermore, Cronbach's alpha of the four factors (.713-.878) exceeded the threshold of .5 (Nunnally 1978), indicating internal consistency. Therefore, the measurement instrument displayed sufficient measurement properties for the confirmatory assessment in this empirical study.

### 2.4.2 Sample and data screening

Data was collected from organizations in the German wood industry. This industry was chosen as the unit of analysis for two important reasons: First, maximizing the utilization of wood resources is highly relevant for this sector, because wood waste has been reported to generate high costs and an increased awareness of environmental concerns have driven companies to use wood resources more efficiently (Daian and Ozarska 2009). Therefore, this industry has also been used as a unit of analysis in other studies investigating resource efficiency (e.g., Daian and Ozarska 2009; Schliephake et al. 2009). Second, the wood industry is characterized by a low- to medium-degree of IS diffusion, in spite of the importance of IT being highlighted in this sector (Trang et al. 2014). Therefore, we expect a greater variance regarding the development of IT capabilities compared to more mature industries. To summarize, we expect the wood industry to represent an appropriate sampling frame for this study.

The sampling frame in this investigation was provided by Fordaq database, which is a network for the wood industry that provides a business database with contact information. Personalized survey invitations to participate in an online survey were distributed among organizations involved in woodworking, wood processing, wood building, or the timber trade. The invitations targeted executive or senior managers with direct responsibility for IT or production functions. A total of 284 questionnaires were completed, 42 of which were excluded due to quality criteria, such as implausibility of demographics or IT usage behaviors. Overall, 242 cases were used as sample for further data analysis. Small- and medium-sized enterprises represent the largest share within our sample: 86 % have fewer than 50 employees, 11 % have between 50 and 250 employees, and 4 % are organizations with more than 250 employees. Most respondents were CEOs (83 %), followed by senior managers (11 %) and other managing positions (6 %). Further, the sub-sectors of the wood industry are represented as follows: woodworking (31 %), wood processing (44 %), wood building (7 %), timber trade (11 %), other (8 %).

Before validating our hypotheses, we tested for non-response bias and common method variance (CMV). Low response rates are typical for web-based surveys (Preston and Karahanna 2009). To test for non-response bias, we checked for differences between the mean values of the construct items (latent variable scores) in the first and the second halves of the sample (Armstrong and Overton 1977). A t-test was performed and revealed no significant differences ($p < .05$). Therefore, we concluded that non-response bias is not a major threat for this study. Since we employed a single-informant approach, we performed the Harman's single-factor test (Podsakoff et al. 2003) to assess the threat of CMV. An exploratory factor analysis including all measurement items was performed. No single factor emerges from the data and no factor accounted for most of the variance (<27.459%), indicating that common method bias will not be a concern in this study.

## 2.5 Data Analysis and Results

To test the theoretical model, we applied a structural equation modeling (SEM) approach. The partial least squares method (PLS) was applied because it is more suitable for formative constructs (Ringle et al. 2012). The software SmartPLS 2.0.M3 (Ringle et al. 2005) was used for the primary analysis. Further, SPSS Statistics 21 was employed for tests that are unavailable in the SmartPLS packages. We followed the widely adopted two-step analytic approach for SEM for data analysis (Anderson and Gerbing 1988). First, we assessed the quality of the measurement model. Next, the structural model was assessed. Finally, we performed a mediation analysis to test whether IT alignment mediates the effect between IT integration and resource efficient production.

### 2.5.1 Measurement model

We first assessed the convergent validity of the constructs. Three measures were evaluated for each reflective measure to assess convergent validity: individual item reliability, average variance extracted (AVE), and composite construct reliability (CR). According to Hulland (1999), item loadings should be above .70. As two items in the IT integration and two items in the input materials scale did not have item loadings above .70 (Hulland 1999), they were dropped and then the procedure was repeated. The results are presented in Table B-33 and show that all remaining items have loadings above .70. Moreover, all item loadings are significant ($p < 0.01$). The AVE exceeds the acceptable limit of .50 and the CR varies between .840 and .947, which is above the lower bound of .70 (Bagozzi and Yi 1988). The criterion of Fornell and Larcker (1981) was used to assess discriminant validity. The square root of AVE for each construct is greater than the variance shared with other constructs, confirming discriminant validity. Finally, we evaluated cross-loadings. All items have higher loadings on their assigned construct than on any other construct in the model (Chin 1998).

*Table B-33. FL, CR, AVE, and inter-construct correlations*

| | FL | CR | AVE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. IT integration | .701-.845 | .908 | .622 | **.789** | | | | | | | | | |
| 2. Operational IT alignment | .751-.912 | .942 | .731 | .582 | **.855** | | | | | | | | |
| 3. Input materials | .704-.824 | .863 | .611 | .265 | .349 | **.782** | | | | | | | |
| 4. Production processes | .755-.850 | .909 | .626 | .294 | .367 | .553 | **.791** | | | | | | |
| 5. Output products | .822-.893 | .891 | .732 | .152 | .198 | .470 | .654 | **.855** | | | | | |
| 6. Logistics processes | .734-.838 | .840 | .637 | .178 | .270 | .430 | .498 | .506 | **.798** | | | | |
| 7. Quality | .859-.913 | .947 | .783 | .282 | .325 | .499 | .583 | .467 | .479 | **.885** | | | |
| 8. Dependability | .846-.893 | .902 | .753 | .241 | .296 | .330 | .546 | .457 | .378 | .673 | **.868** | | |
| 9. Cost | .799-.903 | .883 | .716 | .248 | .297 | .156 | .169 | .071 | .112 | .238 | .229 | **.846** | |
| 10. Flexibility | .872-.934 | .930 | .816 | .180 | .287 | .373 | .588 | .514 | .439 | .609 | .600 | .193 | **.904** |

*FL: Factor loadings; CR: composite reliability; AVE: average variance extracted; Bolded numbers: square root of AVE*

The higher-order reflective-formative constructs, i.e., resource efficient production and operational performance, were estimated using the two-stage approach (Ringle et al. 2012). The outer models of the formative constructs were evaluated for both the relevance of their respective factors and the threat of multicollinearity (Hair et al. 2011). The results show that all factor weights significantly ($p < .01$) account for a relevant share ($w > .10$) of their constructs. Furthermore, to account for the threat of multicollinearity, we evaluated the variance inflation factor (VIF). The VIFs do not exceed the threshold of 5 (<2.055). Our analyses suggest that our measurement model is acceptable and reliable.

### 2.5.2 Structural model

To assess the structural model and test the hypotheses of our research model, we used a bootstrapping re-sampling procedure with 5000 samples. The amount of variance explained in the endogenous constructs is the primary criterion for assessing the PLS structural model (Hulland 1999). The PLS results reveal that the model explains a substantial amount of variance in operational performance ($R^2 = .485$) and operational IT alignment ($R^2 = .339$). Moreover, the explained variance of resource efficient production ($R^2 = .145$) is comparable to other studies on IT-enabled manufacturing capabilities (e.g., Ayabakan et al. 2017; Bharadwaj et al. 2007; Saldanha et al. 2013). However, as the explained variance highly depends on the research context (Hair et al. 2011), we also used the blindfolding procedure to compute the Stone-Geisser $Q^2$ coefficient. All $Q^2$ values clearly exceed the threshold of 0, indicating the overall model's predictive relevance (Chin 1998).

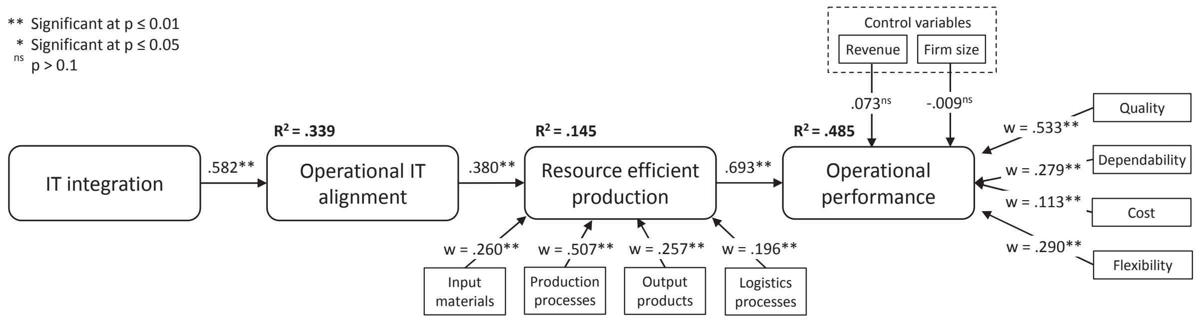


*Figure B-9. PLS results of the structural model*

The results indicate support for Hypothesis 1 and the influence of resource efficient production on operational performance ($b = .693$, $p < .01$). Further, operational IT alignment also significantly influences resource efficient production ($b = .380$; $p < .01$). Regarding Hypothesis 3, the results indicate that IT integration significantly affect the degree of operational IT alignment ($b = .582$, $p < .01$). We find no significant effect of both control variables ($b = -.009$-$.073$, $p > .10$). An overview of the structural model is depicted in Figure B-9.

### 2.5.3 Mediation analysis

To analyze mediating mechanisms, we followed the approach by Subramani (2004). First, mediation analysis technique (Hoyle and Kenny 1999) was used to assess the magnitude and significance of the mediated path. We calculated the magnitude of the mediating path by multiplying the standardized path coefficients of each single path. Inference statistics were computed based on the standard deviation and standardized path coefficients of the direct paths among the independent, mediating, and dependent variable. The result of the individual mediation path (.221) reveals a significant effect (z stat = 5.332) for Hypothesis 4. Second, we compared nested models (Chin et al. 1996). We analyzed the explained variance by adding an additional path from IT integration to resource efficient production. The significance of the increased explanatory power was assessed by calculating the effect size [$(R^2_{\text{partial mediation}} - R^2_{\text{full mediation}})/(1 - R^2_{\text{partial mediation}})$] and computing the the pseudo F-statistic [$=f^2 * (n - k - 1)$, df = $(1, (n - k))$], where $n$ is the sample size and $k$ the number of independent variables. The small effective size ($f^2 = .008$) and the non-significant pseudo $F(1, 238)$-statistic of 1.965 reveal no significant effect on the explanatory power by adding the newly introduced direct path. Therefore, our results indicate that the relationship between IT integration and resource efficient production is fully mediated by operational IT alignment, giving empirical support for Hypothesis 4.

## 2.6 Discussion and Conclusion

Our study aimed to investigate whether IT leads to resource efficient production and to analyze underlying IT capabilities and mechanisms. Based on the RBV and the dynamic capability theory, we developed a theoretical research model and framework and tested it with cross-sectional data gathered from 242 organizations working in the German wood industry. Our results first reveal that resource efficient production significantly contributes to operational performance ($b = .693$, $p < .01$), indicating the relevance for achieving competitive advantage in manufacturing firms. Although it has been argued that resource efficiency can hinder adaptability and cause negative performance impacts (Adler et al. 2009), our findings are largely consistent with previous findings (e.g., Browning and Heath 2009; Modi and Mishra 2011), indicating positive performance outcomes, including flexibility. Next, our results show that operational IT alignment is a primary driver for resource efficient production. The results underline the business value impact of IT alignment in previous research and the importance of operational alignment in manufacturing contexts (Gerow et al. 2014, 2015). Moreover, our results highlight the role of dynamic capabilities for realizing business value in manufacturing. Therefore, firms can achieve value-adding resource efficient production capabilities by continuously aligning IT and business infrastructures and processes. Furthermore, the results indicate that IT integration has a significant impact on IT alignment ($b = .582$, $p < .01$) and a mediating effect on resource efficient production (path coefficient = .221). Consistent with previous research (Barua et al. 2004; Dong et al. 2009; Rai et al. 2006), IT integration can therefore be interpreted as lower-order capability, which enhances business value in terms of resource efficient production by shaping the development of dynamic capabilities, i.e. operational IT alignment.

Our study offers three major contributions to the body of literature. First, we integrate IT-related capabilities into the value creation process through resource efficient production. Although previous research has widely investigated the role of resource efficiency for realizing performance (Adler et al. 2009), the impact of IT-related capabilities has rarely been examined. Our results show that IT alignment significantly contributes to resource efficient production, which reveals the important role of IT capabilities for achieving resource efficiency. Besides, we developed a measurement construct for resource efficient production that can be adapted by further studies in this research context. Second, we contribute to prior IS research on IT-enabled manufacturing performance (e.g., Ayabakan et al. 2017; Banker et al. 2006; Rai et al. 2006) by examining its effect on resource efficient production. Our study thus introduces resource efficient production as another important IT business value dimension in manufacturing contexts. Finally, our results provide theoretical support for the RBV and the dynamic capability theory in IS research by showing that dynamic IT capabilities are the primary source of resource efficient production, mediating the effect of lower-order capabilities. We applied this view, in specific, to IT integration as lower-order capability and operational IT alignment as dynamic capability. This can improve our understanding of the underlying mechanisms of IT-enabled manufacturing performance in general and resource efficient production in particular.

For practitioners, this study shows that managers should recognize operational IT alignment capabilities as a central source for achieving resource efficient production. Moreover, they should evaluate their IT integration capabilities to foster IT alignment. However, a sole focus on investments in integrated systems is insufficient. Organizations should rather consequently align business and IT processes and infrastructures to ensure that IT capabilities respond to challenges of the external environment, resulting in business value in terms of resource efficient production. Consequently, managers should, at the same time, be aware that realized resource efficiency through their IT capabilities is temporary and thus foster IT alignment to sustain such benefits.

The results of this study must be interpreted with caution due to the following limitations, which also provides avenues for future research. First, our study comes with typical limitations of cross-sectional and quantitative research designs. Although our results indicate that CMV and non-response bias is not a threat, longitudinal and multi-informant approaches could improve the reliability of the results and also give insights into the dynamic mechanisms of IT-enabled resource efficient production. Second, specific characteristics of the German wood industry might affect the generalizability of our results. Although this industry represents an appropriate unit of analysis for examining issues regarding resource efficiency, future research could validate and extend our findings to other industries and cultural contexts. Third, future research could explore other IT-related and organizational capabilities to better understand the mechanisms that lead to resource efficient production. Fourth, scholars note that resource efficient firms are at a greater risk of becomig rigid and inflexible to respond to environmental changes (Adler et al. 2009). Although we could demonstrate a positive relationship between resource efficient production and performance, including flexibility, future research could investigate the role of IT capabilities regarding tensions between resource efficiency and flexibility. Finally, we did not consider direct effects between IT capabilities and operational performance as this was not the focus of our study. However, analyzing the mediating mechanisms between IT capabilities, resource efficient production, and operational performance could provide additional insights regarding IT-enabled performance in the manufacturing context.

## 2.7 Appendix

*Table B-34. Operationalization of the measurement scales*

| Construct | Scale |
|---|---|
| **Operational Performance** (Wang et al. 2013) | (How does your current operational performance compare with main competitors?): **Quality:** 1. Product features. 2. Product reliability. 3. Product durability. 4. Product performance. 5. Conformance to the product specification. **Dependability:** 1. Speed of delivery. 2. Reliability of delivery. 3. Lead time. **Cost:** 1. Inventory costs. 2. Shortage costs. 3. Costs of defected goods. **Flexibility:** 1. Process flexibility. 2. Volume flexibility. 3. Mix flexibility. |
| **Resource Efficient Production** (Self-developed) | **Input materials:** 1. The proportion of finite input materials is low. * 2. The proportion of renewable input materials is high. 3. The proportion of reusable input materials is high. * 4. Input materials possess a high quality to ensure optimal durability of materials. 5. The error rate of input materials is low to avoid loss of resources. 6. We coordinate in production in terms of volume and time to avoid loss of resources. **Production processes:** 1. We use accurate machines to avoid defects of products. 2. Losses during production due to machinery failures are low. 3. The used technology in the production process is being aligned with the technological progress. 4. The loss of quality due to storage of intermediate products is low. 5. Employees in production are highly aware of the efficiency of the production process. 6. Employees in production are highly motivated for an efficient use of resources. **Output products:** 1. Supply and demand are aligned to minimize loss of resources. 2. Production residues are kept low. 3. Non-reusable production residues are kept low. **Logistics processes:** 1. We use transportation with a minimum consumption of resources. 2. The efficiency of our transportation routes in our supply chain is optimized. 3. Unnecessary packages are kept low. |
| **IT Alignment** (Gerow et al. 2015) | 1. Our IT processes support our business processes. 2. We adapt our IT processes to our business processes. 3. Our IT processes and business processes match each other. 4. We identify the fit between our IT infrastructure and our business infrastructure. 5. Our IT infrastructure and business infrastructure correspond to each other. 6. Our IT infrastructure aligns with our business infrastructure. |
| **IT Integration** (Bharadwaj et al. 2007) | (Our production/resource planning system allows us integrated access to): 1. All customer-related data (e.g. Service contracts, feedback, etc.). * 2. All order-related data (e.g., order status, handling requirements, etc.). * 3. All production-related data (e.g., resource availability, quality, etc.). 4. All market-related data (e.g., promotion details, future forecasts, etc.). (To what extent does your resource-planning system facilitate the following coordinated activities with your suppliers?): 5. Knowledge of the maintenance of inventory mix/ levels. 6. Delivery scheduling and tracking. (To what extent does your resource-planning system facilitate the following coordinated activities with your suppliers?): 7. Knowledge of the maintenance of inventory mix/ levels. 8. Delivery scheduling and tracking. |

*Note: * Item has been removed due to low factor loadings.*

# C. Contributions

Focusing on IT-based value co-creation research, this cumulative thesis aims to accomplish three goals. First, it strives to resolve contradictory findings of existing research on IT business value creation in inter-organizational networks by integrating results of previous studies. Second, it aims to examine key capabilities and interdependencies of IT-based value co-creation mechanisms by extending reference theories. Third, it pursues to offer insights on IT-based value co-creation in the wood industry by adapting the theoretical findings to this specific context. Based on the applied three-step reference theorizing approach, six studies have been conducted to answer the proposed research questions.

Initially, this chapter recapitulates the main findings of the foregoing studies, synthesizes them into an overarching IT-based value co-creation model, and provides a more holistic view of the reference theorizing approach (Section C.I). Subsequently, overall implications for research and practice are presented (Section C.II). Finally, the last section addresses the limitations of this thesis, and provides avenues for future research (Section C.III).

# I. Findings on IT-Based Value Co-Creation in Inter-Organizational Networks

This section summarizes and synthesizes the findings of the six studies included in this thesis, and provides answers to the three research questions posed in Section A.I.2. The summary is structured along three subsections: contradictory results of research on IT business value creation in inter-organizational networks (C.I.1), key capabilities and interdependencies of IT-based value co-creation mechanisms (C.I.2), and business value dimensions and contextual factors of IT-based value co-creation in the wood industry (C.I.3). These subsections reflect the three-step reference theorizing approach, i.e., theory integration (B.I), theory extension (B.II), and theory adaptation (B.III). Finally, all findings are related to each other and synthesized into a model of IT-based value co-creation that extends current theory on IT business value (C.I.4).

## I.1 Findings on Resolving Contradictory Results of Research on IT Business Value Creation in Inter-Organizational Networks

In Part B.I, two meta-analyses have been conducted with the aim of integrating findings on the research domain. Consequently, the two studies provide answers to the first research question on how contradictory results of research on IT business value creation in inter-organizational networks can be resolved by drawing on reference theories and considering contextual factors. The first study (#1) adapts the perspective of the resource-based view and relational view in order to investigate the relationship between inter-organizational IT capabilities and organizational performance. The second study (#2) focuses on organizational agility as a type of business value while adapting the resource-based view and dynamic capability theory. Both studies additionally analyze the moderating role of contextual factors on the investigated relationships.

*Table C-1. Core research question and core contribution of Study #1*

| **Summary of Study #1** | |
|---|---|
| **Title** | Synthesizing and Integrating Research on IT-Based Value Co-Creation: A Meta-Analysis |
| **Core research question** | How can contradictory findings on the relationship between inter-organizational IT factors and business value be resolved? |
| **Core contribution** | The study resolves contradictory findings on IT-based value co-creation by adopting the theoretical perspective of the resource-based view and the relational view, showing that IT-based inter-organizational assets, knowledge sharing, complementary capabilities, and governance as capabilities are the sources of relational value. Moreover, contextual factors in terms of relationship type, region, and measurement type influence the results, and need to be considered by research. |

Study #1 aimed to integrate research findings on the relationship between IT factors and business value dimensions in inter-organizational networks. The study thus contributes by resolving contradictory findings in the research field. The results indicate that network partners should not focus on IT resources alone, but should rather develop unique inter-organizational IT capabilities to create business value, showing the nonexistence of the productivity paradox (Brynjolfsson 1993) in research on IT-based value co-creation. Moreover, IT-based inter-organizational assets, knowledge sharing, complementary capabilities, and governance all significantly impact business value, providing strong theoretical support for the relational view (Dyer and Singh 1998). Nevertheless, the study also shows that interdependencies between these factors may exist and need to be analyzed in more detail. For instance, the results indicate a mediating relationship between IT-based knowledge sharing and governance on the one hand, and IT-based inter-organizational assets and complementary capabilities on the other hand. This is also reflected by the greater effect of IT-based inter-organizational assets on relational-level value in contrast to the other three IT-based sources of relational value which show a higher correlation with process-level outcomes. Furthermore, the study also highlights the importance of contextual factors in explaining IT business value creation in inter-organizational networks. In particular, research needs to consider the type of inter-organizational relationship and the region in which the network cooperates. In addition, methodological attributes, i.e. the use of perceptual in contrast to objective performance measures, explain diverging research results.

*Table C-2. Core research question and core contribution of Study #2*

| **Summary of Study #2** | |
|---|---|
| **Title** | Diving into the Relationship of Information Technology and Organizational Agility: A Meta-Analysis |
| **Core research question** | How can contradictory findings on the relationship between IT and organizational agility be resolved? |
| **Core contribution** | The study resolves contradictory findings on IT-enabled agility by adopting the theoretical perspective of the resource-based view and dynamic capability theory, showing that dynamic IT capabilities are the main IT-related drivers of both entrepreneurial and adaptive organizational agility. |

The second study (#2) aimed to integrate research findings on the relationship between IT and organizational agility as specific type of business value. Hence, the study contributes by explaining contradictory results in the research domain. The findings reveal that inter-organizational networks should focus on IT capabilities as an important source of organizational agility, and that enabling effects outperform possible negative effects as suggested by previous research (e.g., Overby et al. 2006). Therefore, a paradox in this research stream cannot be confirmed as the analysis reveals a significant effect of IT capabilities on both entrepreneurial and adaptive agility.

Moreover, inter-organizational networks should focus on dynamic IT capabilities and, therefore, on the ability to continuously adapt and renew information systems for changing business environments. This has been confirmed by the greater influence of dynamic IT capabilities on organizational agility in contrast to static IT capabilities. The study also shows that the theoretical relationships hold true in various conditions, i.e., the attributes of the analyzed studies. In contrast to suggestions by previous researchers, the type of respondents, level of analysis, and publication type did not influence the magnitude of the analyzed correlations.

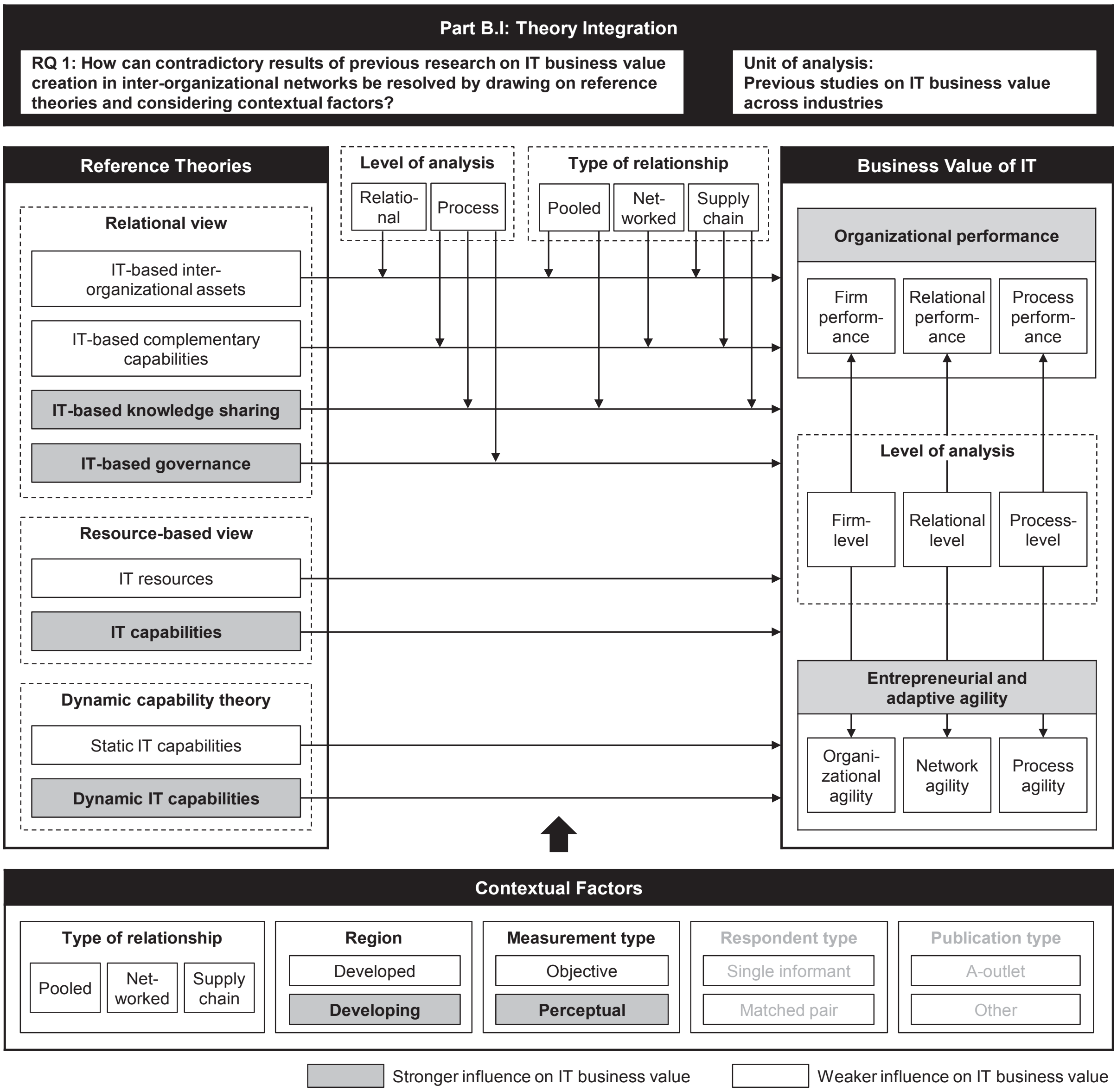


*Figure C-1. Synthesized findings on resolving contradictory results of research on IT business value creation in inter-organizational networks*

To summarize, the integrated findings of Part B.I are depicted in Figure C-1. Both studies (#1 and #2) show that contradictory findings on the relationship between IT and business value in inter-organizational networks can be resolved by adopting a resource-based theoretical perspective and by considering the contextual conditions. Therefore, IT capabilities are regarded as the main drivers of IT-enabled business value in inter-organizational networks. In particular, interdependencies between the factors derived from the relational view and dynamic capabilities need to be conceptualized as primary IT mechanisms of value co-creation, which is the focus of Part B.II. Moreover, contextual factors in terms of the network type and the underlying region affect how inter-organizational networks gain value from IT, implying the need to grasp details of IT-based value co-creation in the wood industry (Part B.III).

### I.2 Findings on Key Capabilities and Interdependencies of IT-Based Value Co-Creation Mechanisms

Part B.II comprises two studies that have been conducted with the goal of extending theories in the research field. The studies thus address the second research question by examining key capabilities and interdependencies of IT-based value co-creation mechanisms. Based on the findings of Part B.I, both studies adopt a resource-based perspective. The first study (#3) extends the relational view of the firm by reconceptualizing the sources of relational value to the IS context, and proposing a new logic between the factors. The second study (#4) extends the IT alignment concept to the network context by adopting a dynamic capability perspective, and investigating its relationship with other inter-organizational IT capabilities and relationship performance. Both studies have been conducted in regional networks in Germany.

*Table C-3. Core research question and core contribution of Study #3*

| **Summary of Study #3** | |
|---|---|
| **Title** | IT-Based Value Co-Creation: A Reconceptualization and Extension of the Relational View |
| **Core research question** | How can the relational view be reconceptualized and extended when applied to the context of information systems? |
| **Core contribution** | The study contributes by extending the relational view to the IS context, and by providing a new conceptualization and configuration of the constructs. It shows that digitally enabled interfirm capabilities (IT-enabled interfirm integration and complementary capabilities) are the immediate antecedents of relational value, thereby mediating the impact of information processing capabilities (IT-enabled knowledge sharing and governance) on relational value. |

Study #3 reconceptualizes the relational view from Dyer and Singh (1998) by providing a new conceptualization of the constructs when applied to the IS context and by reconfiguring its underlying logic. It, therefore, extends the understanding of how relational value can be achieved when IT is embedded into context, and how IT capabilities interdepend in this value generating process. The results reveal that the four IT-enabled sources of relational value can be classified into two groups, with digitally enabled interfirm capabilities (i.e., IT-enabled interfirm integration and complementary capabilities) being the primary antecedents of relational value as well as the mediating factors of the relationship between information processing capabilities (i.e., IT-enabled knowledge sharing and governance) and co-created value. Therefore, network partners should recognize digitally enabled interfirm capabilities as a primary means of creating value through inter-organizational IT investments. IS-induced exploitation and exploration were found to be the underlying mechanisms of these capabilities. In contrast to the reference theory, i.e., the relational view, information processing capabilities do not directly influence relational value. Rather, network partners first need to exploit the provided and transferred information in networked business activities by building digitally enabled interfirm capabilities in order to ultimately realize the anticipated benefits from IT.

*Table C-4. Core research question and core contribution of Study #4*

| **Summary of Study #4** | |
|---|---|
| **Title** | The Role of Inter-Organizational IT Alignment for Co-Creating Value: Empirical Evidence from Regional Network Collaborations |
| **Core research question** | What is the role of inter-organizational IT alignment as a dynamic capability for co-creating value? |
| **Core contribution** | The study contributes by demonstrating that inter-organizational IT alignment is a dynamic capability that directly leads to co-created value. Moreover, IT alignment can be interpreted as a higher-order capability that mediates the relationship between inter-organizational IT capabilities (i.e., IT infrastructure integration, information capabilities, and IT-enabled coordination) and relationship performance. |

The second study in Part B.II (#4) analyzes the role of IT alignment for value co-creation. It, therefore, extends the IT business alignment literature, which highlights the important role of alignment for achieving business value, but misses an inter-organizational analysis (Coltman et al. 2015). The study demonstrates that IT alignment can be conceptualized as a higher-order dynamic capability and accordingly as the ultimate driver of relational value. Inter-organizational networks thus need to shape capabilities that ensure an ongoing fit of network IT and business infrastructures and processes in order to handle dynamics of network IT and business components, such as the technical (de-)integration of network partners. Moreover, the study identifies three antecedents of inter-organizational IT alignment: IT infrastructure integration, information capabilities, and IT-enabled coordination. In previous literature, there were inconsistent conceptualizations regarding their direct or indirect impact on relational value (Barua et al. 2004; Wang et al. 2013; Zhu and Kraemer 2005). The results reveal that IT alignment is an important explanatory factor in this context, resulting in a mediating effect on the relationship between inter-organizational IT capabilities and relationship performance. Therefore, network partners need to continuously align their IT and business infrastructures and processes to fully realize the anticipated relational rents from inter-organizational IT capabilities.

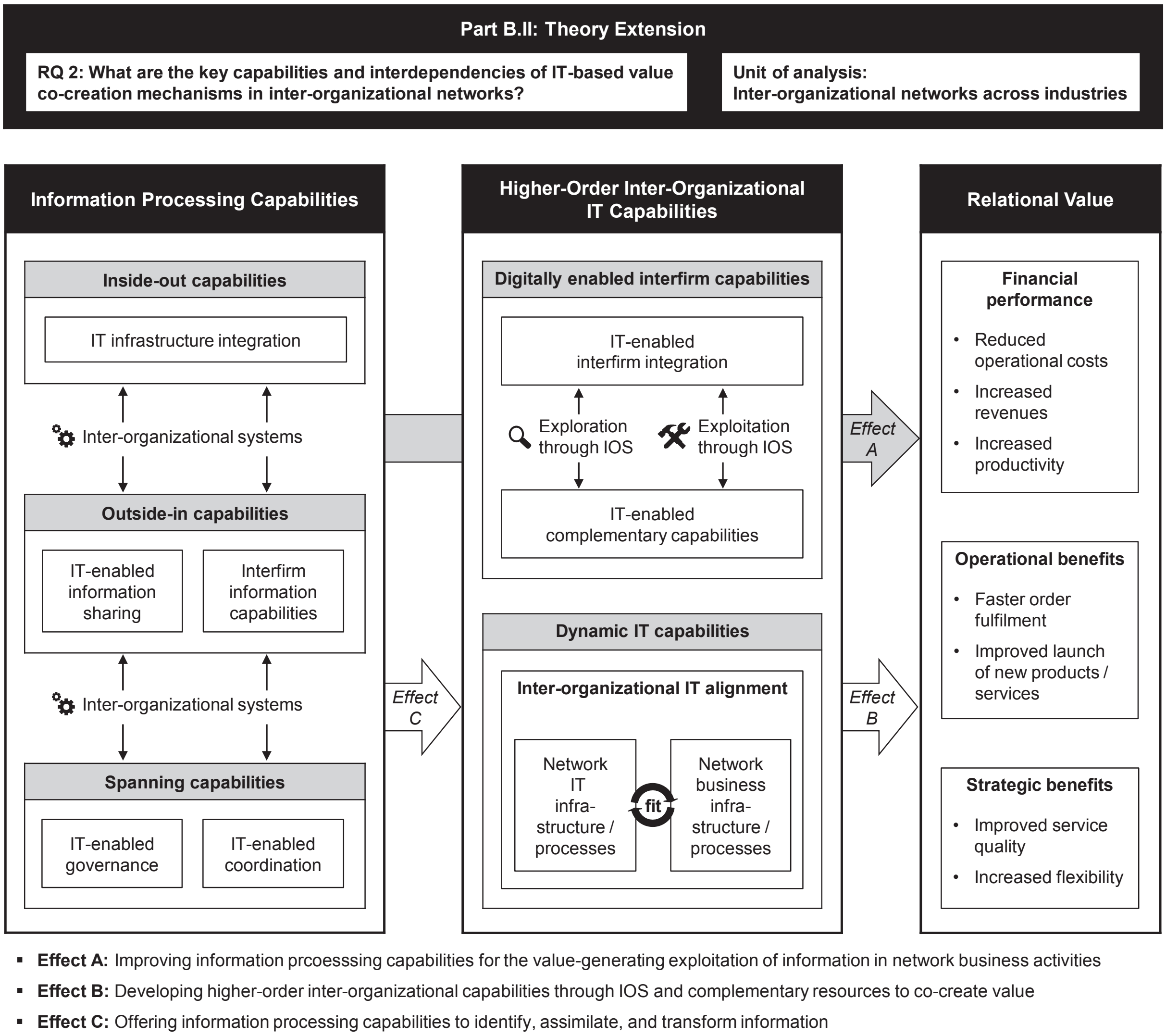


*Figure C-2. Synthesized findings on key capabilities and interdependencies of IT-based value co-creation mechanisms*

Synthesizing the findings from both studies (see Figure C-2), IT-based value co-creation mechanisms in inter-organizational networks can be theorized as a capability-building process, comprising a hierarchy of IT capabilities. First, information processing capabilities provide the foundation for co-creating value, consisting of inside-out (i.e., IT infrastructure integration), outside-in (i.e., IT-enabled information sharing and interfirm information capabilities), and spanning capabilities (i.e., IT-enabled governance and coordination). Inter-organizational systems are embedded in these information processing capabilities. Second, higher-order inter-organizational IT capabilities are the primary sources of relational value. They consist of digitally enabled interfirm capabilities (i.e., IT-enabled interfirm integration and complementary capabilities) with the underlying mechanisms of exploration and exploitation through IOS, and dynamic IT capabilities (i.e., inter-organizational IT alignment). Overall, this implies three interrelated effects of IT capabilities on relational value. First, networks can improve their information processing capabilities in order to exploit the valuable information in networked business activities (Effect A). Second, network partners can blend IOS with complementary inter-organizational resources to develop higher-order IT capabilities to co-create value (Effect B). Finally, information processing capabilities provide the infrastructural possibilities to identify, assimilate, and transform information as a basis for value co-creation (Effect C).

## I.3 Findings on Business Value Dimensions and Contextual Factors of IT-Based Value Co-Creation in the Wood Industry

Part B.III has aimed to adapt the previously developed IT-based value co-creation mechanisms (Part B.II) to the context of inter-organizational networks in the wood industry. Two studies have been carried out to scrutinize the contextual factors and business value dimensions in this particular context, therefore responding to the third research question. As Study #1 showed that contextual factors influence the results of IT business value creation in inter-organizational networks, the first study in this part (#5) sheds light on the role of environmental uncertainties in the co-creation of IT value. The second study (#6) delves deeper into the business value dimension and examines how IT enables resource efficient production. Both studies have been conducted in organizations in the German wood industry to capture its specific characteristics.

*Table C-5. Core research question and core contribution of Study #5*

| **Summary of Study #5** | |
|---|---|
| **Title** | Shifting from Justification to Understanding: The Impact of Environmental Uncertainty on the Value of IT-Enabled Collaboration in Supply Chains |
| **Core research question** | How does IT-enabled collaboration lead to supply chain performance under environmental uncertainties in supply chains in the wood industry? |
| **Core contribution** | The study contributes by exposing the important role of contextual factors in IT-based value co-creation. It shows that environmental uncertainties, i.e., supply and demand uncertainty, moderate the effect of IT-enabled collaboration on supply chain performance for organizations in the wood industry. |

The first study (#5) investigates IT business value creation in the presence of contextual factors in supply chains in the wood industry. As Study #4 showed that information processing capabilities are an important source of relational value by enabling inter-organizational higher-order capabilities, Study #5 adapts the information processing view (Galbraith 1973). The results reveal that IT-enabled collaboration as such a capability significantly impacts supply chain performance in the wood sector. More importantly, environmental uncertainties are identified as contextual factors in this industry given that demand and supply uncertainties strengthen the effect of IT-enabled collaboration on supply chain performance. However, in contrast to expectations from previous studies (Fynes et al. 2004; Rosenzweig 2009), technological and product-related uncertainties do not influence the results. The study, therefore, demonstrates that a detailed consideration of contextual conditions is beneficial for analyzing how inter-organizational networks co-create IT value. Accordingly, firms in the wood sector especially profit from IT investments when operating under fluctuating conditions of supply and demand.

*Table C-6. Core research question and core contribution of Study #6*

| **Summary of Study #6** | |
|---|---|
| **Title** | Creating Value through IT-Enabled Resource Efficient Production: A Dynamic Capability Perspective |
| **Core research question** | How do IT capabilities lead to resource efficient production in supply chains in the wood industry? |
| **Core contribution** | The study contributes by expanding the business value dimension for the specific context of the wood industry. Resource efficient production as the ultimate driver of performance is developed as a new construct. The study shows that IT alignment as a dynamic capability is a central IT value mechanism for achieving resource efficiency, thereby mediating the impact of IT integration as a lower-order capability. |

Finally, the last study of this cumulative dissertation (#6) delves deeper into the business value resulting from IT capabilities in supply chains in the wood industry. The study demonstrates that resource efficient production is a direct source of operational performance, and consists of four underlying dimensions, i.e., input materials, production processes, output products, and logistics processes. The newly developed construct, i.e., resource efficient production, can be further adapted by researchers and practitioners to evaluate the level of resource efficiency of a company and its network partners. Moreover, the underlying IT-enabling mechanisms are identified. Based on the findings of Study #2 and Study #4, the investigation conceptualizes dynamic capabilities (Teece et al. 1997) as primary drivers of business value in inter-organizational networks. The findings reveal that IT alignment can be interpreted as the central IT-related source of resource efficient production, and that it fully mediates the impact of IT integration as information processing capability. Therefore, networks in the wood sector need to build IT capabilities that foster the adaption to challenges of the external environment in order to realize business value in terms of IT-enabled resource efficient production.

Figure C-3 depicts the synthesized findings for business value creation in inter-organizational networks in the wood industry. The IT-based value co-creation mechanisms developed in Part B.II (conceptual level) can be adapted to the specific context of the wood industry (empirical level). Accordingly, IT-enabled collaboration from the perspective of the relational view, on the one hand, and IT alignment as a mediator of IT integration from the dynamic capability perspective, on the other hand, are identified as IT-based value co-creation mechanisms for organizations in the wood sector. Additionally, the theoretical relationships are modified to the specific context of the wood industry. First, contextual factors in form of environmental uncertainties moderate the effect of IT on business value. Second, resource efficiency is conceptualized as an additional dimension of business value and ultimate driver of organizational performance. To summarize, the findings modify extant theoretical concepts to better understand how IT leads to value for inter-organizational networks in the specific context of the wood industry.

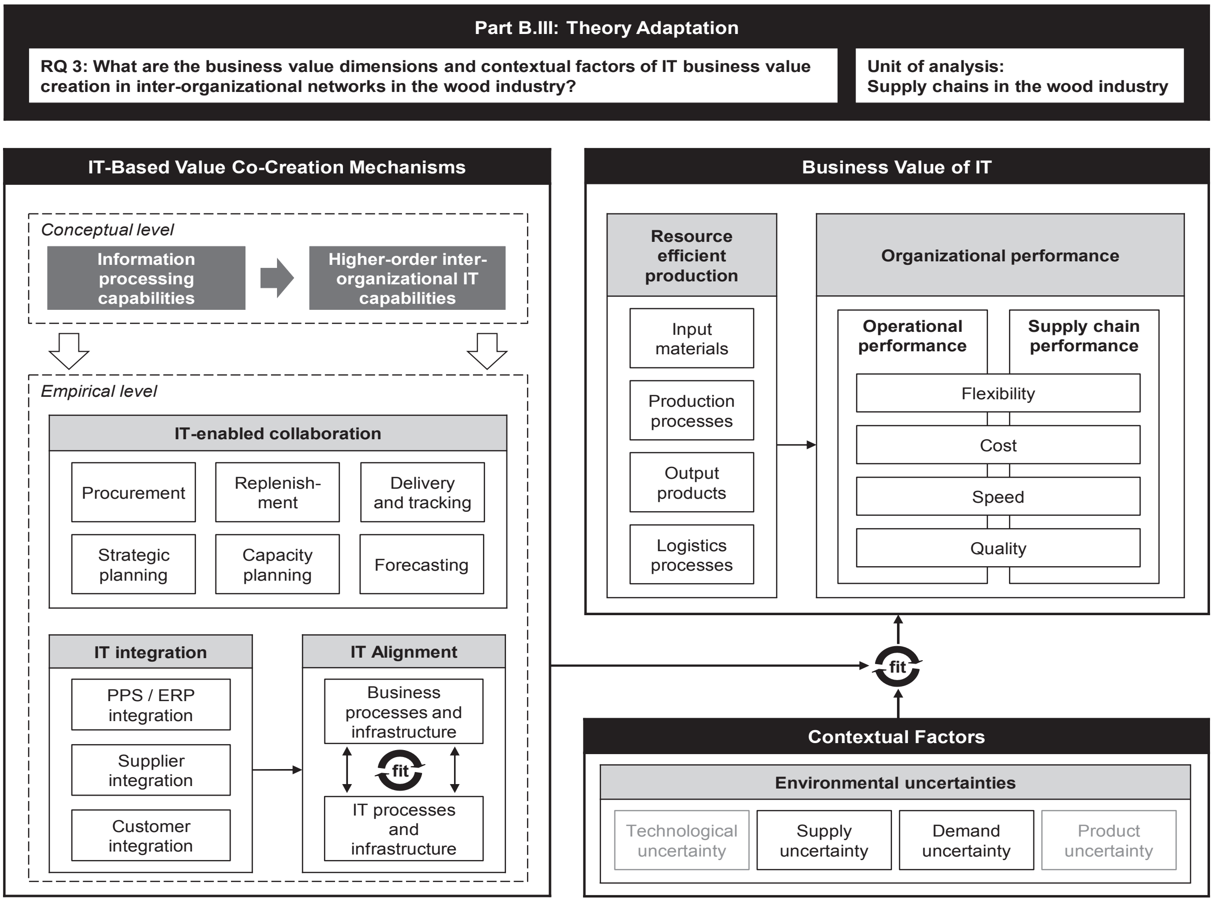


*Figure C-3. Synthesized findings on business value dimensions and contextual factors of IT-based value co-creation in the wood industry*

## I.4 Synthesis: Extending Theory on IT Business Value to Inter-Organizational Networks by Reference Theorizing

Each of the subsections in Part B focused on one step of the reference theorizing approach used in this thesis. Altogether, they contribute to the overarching goal of this cumulative thesis, i.e., to extend the understanding of how IT leads to business value in inter-organizational networks. Therefore, they provide the foundation for extending theory on IT business value to the inter-organizational level of analysis. Accordingly, this section first integrates the main findings of the six separate studies by showing how they relate to each other (see Figure C-4). Afterwards, these findings are synthesized into a model of IT-based value co-creation that extends current theorizing in research on IT business value (see Figure C-5). Additionally, a holistic view of the reference theorizing approach is provided (see Figure C-6).

Although the six studies addressed one of the proposed three research questions respectively (see Section A.I.2), they are logically intertwined in their entirety (see Figure C-4). Part B.I has aimed to integrate previous research findings by drawing on reference theories and analyzing contextual factors. It laid the foundations for Part B.II. First, Part B.I demonstrates that IT-related factors should be conceptualized as IT capabilities since they show a higher correlation with business value. Therefore, the empirical studies conducted in Part B.II analyzed inter-organizational IT capabilities as mechanisms of value co-creation. Second, although Study #1 shows that all four sources derived from the relational view enhance business value, the analysis reveals interdependencies between these factors. Therefore, Study #3 extends the relational view by reconceptualizing the factors and logic of this reference theory to the IS context. Third, Study #2 demonstrates that dynamic IT capabilities play an important role in achieving business value in terms of organizational agility. Building upon this finding, Study #4 understands inter-organizational IT alignment as a dynamic capability and, thus, as a primary source of relational value. As an interim result, the studies in Part B.II extend the reference theories identified in Part B.I by developing and adding new constructs, configurations, and logic.

Proceeding further, Part B.I and Part B.II laid the foundation for Part B.III. Part B.I already highlights that research results in IT business value creation depend on contextual factors, indicating the need to analyze specific characteristics of supply chains in the wood industry. Part B.II provides the theoretical understanding for investigating IT-based value co-creation mechanisms in this unique context. In particular, while Study #5 adapts the perspective of the relational view with IT-enabled collaboration as an information processing capability resulting in a digitally enabled interfirm capability, Study #6 conceptualizes IT alignment as a dynamic capability and IT integration as an information processing capability. Both studies show that the developed IT-based value co-creation mechanisms developed in Part B.II can be adapted to the specific context of the wood industry, substantiating the generalizability of the theoretical models. Yet, the theoretical models are also modified by adding the moderating role of environmental uncertainties and by expanding the business value dimension in terms of resource efficiency, showing the important role of the underlying context.

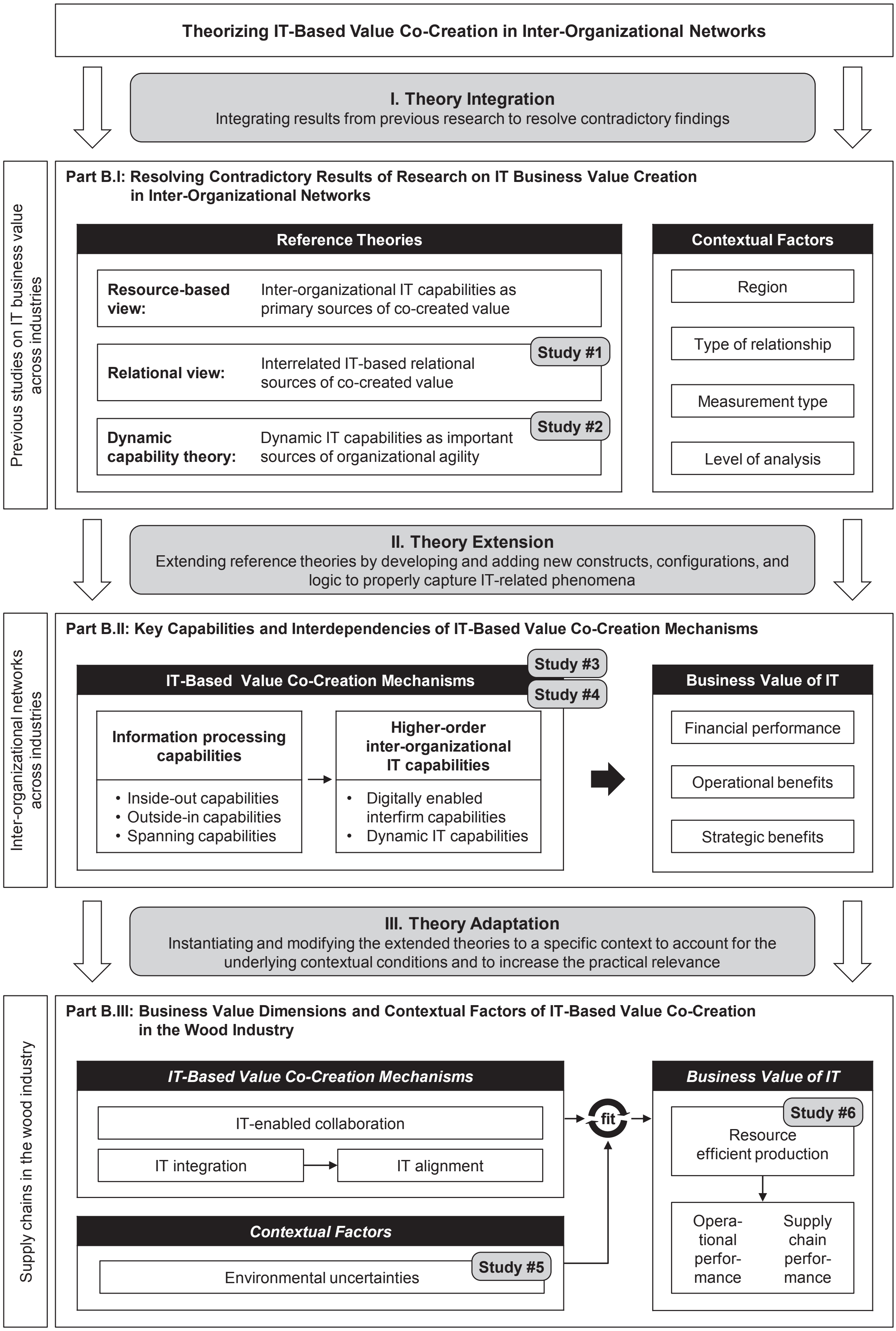


*Figure C-4. Relation between studies included in the thesis – A reference theorizing perspective on IT-based value co-creation in inter-organizational networks*

As clarified beforehand, each of the six studies have aimed to advance the particular understanding of how value can be co-created in inter-organizational networks. Beyond that, a synthesis of all studies amounts to the extension of current theorizing on IT business value in general (Kohli and Grover 2008; Masli et al. 2011; Melville et al. 2004; Schryen 2013). More specifically, the overall research findings are synthesized into a model of IT-based value co-creation (see Figure C-5). Exemplarily, this model is based on and hence extends the renowned IT business value framework by Melville et al. (2004). In the following, the individual parts of the proposed model are explained and discussed in relation to extant literature.

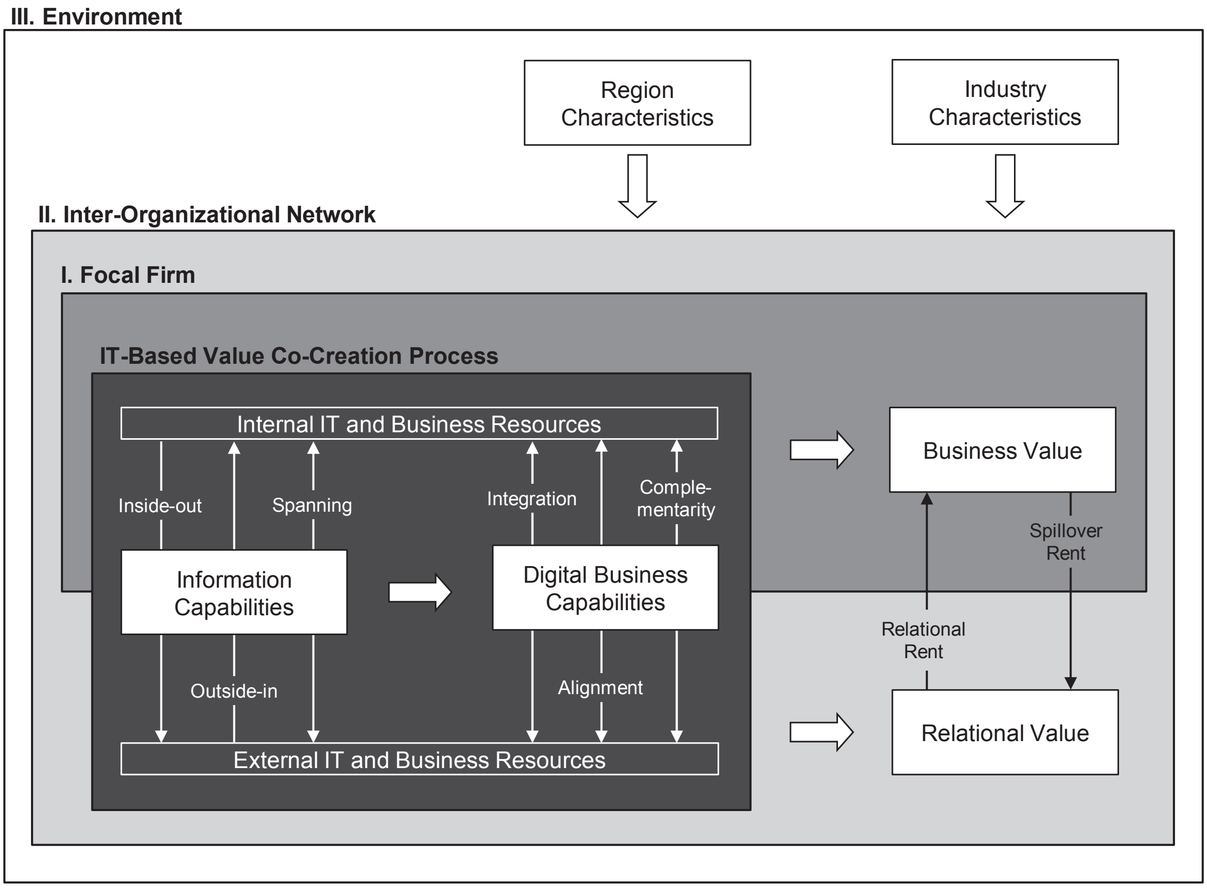


*Figure C-5. IT-based value co-creation model – An extension of Melville et al. (2004)*

**Inter-organizational network and focal firm:** Melville et al. (2004) already suggest that trading partner resources and business processes influence the IT business value generation process of the focal firm. However, they treat the inter-organizational perspective as an external factor in the competitive environment. Besides, other acknowledged models on IT business value (e.g., Kohli and Grover 2008; Masli et al. 2011; Schryen 2013) lack the inter-organizational perspective at all. Yet, traditional firm boundaries have recently begun to blur, and IT and non-IT resources of network partners have increasingly become integral parts of IT business value generation (Grover and Kohli 2012). Accordingly, conventional knowledge on IT business value needs to be integrated with findings from IT-based value co-creation research (Ning and Tanriverdi 2017). This concern is the primary focus of this thesis. Therefore, external IT and business resources must be included into the IT business value generation process.

**Digital business capabilities:** Traditional IS research (see Figure A-6) conceptualizes IT business value generation as a process (IT investments → Capabilities → Performance) by clearly separating between IT and business factors (Drnevich and Croson 2013). This corresponds to treating IT as a separable artifact (El Sawy 2003) that is exogenous to theory (Grover and Lyytinen 2015). Nowadays, IT is yet increasingly fused with the internal and external business environment, implying seamless connectivity and integration between IT and business (El Sawy 2003). Therefore, in contrast to traditional IT business value models which propose a contribution of IT to complementary business capabilities and processes, contemporary research needs to identify digitized capabilities where IT is deeply embedded in the business environment (Kohli and Grover 2008). The studies included in this thesis demonstrate that IT-enabled interfirm integration and complementarity as well as dynamic IT capabilities can be defined as such competencies. For instance, Study #3 conceptualizes IT-enabled interfirm integration as a digitally enabled capability where IOS are embedded in integrated inter-organizational business activities, e.g., in order to co-create digital products and services. This contrasts with previous studies which separate the IT artifact from non-IT related interfirm integration constructs (e.g., Chen et al. 2013; Rai et al. 2006). Accordingly, instead of focusing on IT investments and their link with capabilities which then result in value (IT investments → Capabilities → Performance), research is shifting towards a new business value generation process with digital business capabilities as the primary sources of IT-based business and relational value (Digital business capabilities → Value).

**Information capabilities:** Companies increasingly invest in capturing, analyzing, managing, and processing massive amounts of data to generate new benefits from high quality information. Therefore, the focus shifts from the value of information technology to the generation of value from information (Bharadwaj et al. 2013). In this thesis, this issue is addressed by the notion of information capabilities (i.e., inside-out, outside-in, and spanning capabilities) in the business value generation process. Moreover, the question of how these information capabilities relate to digital business capabilities arises as a result (Kohli and Grover 2008). It can be argued that information capabilities and digital business capabilities have different but complementary roles in enhancing business value. While processing and analyzing huge amounts of data provides an important foundation for creating value, full benefits result from its exploitation in digitized interand intrafirm business capabilities (Malhotra et al. 2005; Roberts et al. 2012). For instance, Study #3 and #4 show that sharing high quality data between network partners does not directly lead to value without first encouraging the development of higher-order, digitized capabilities. This also provides an explanation for studies that postulate but do not observe the impact of information capabilities on performance (e.g., Chuang and Lin 2017; Saldanha et al. 2013). In summary, IT business value generation, including the inter-organizational level of analysis, can be described as a process of developing and leveraging information capabilities and digital business capabilities (Information capabilities → Digital business capabilities → Value).

**Value:** While traditional IT business value research is constrained to direct economic and financial performance measures, scholars increasingly emphasize alternate and broadened measures of value (Masli et al. 2011). Moreover, pure performance metrics underestimate the true benefits of IT, especially regarding information and digital business capabilities (Kohli and Grover 2008). For instance, organizational agility and flexibility represent critical intangible business value dimensions (Kohli and Grover 2008; Lee et al. 2015), a fact that has been highlighted by Study #2. Therefore, the endogenous variable needs to be conceptualized at a broader level than business process or organizational performance, and must include intangible IT value dimensions as well. Moreover, IT does not only impact business value within the focal firm, but also the relational value resulting from collaboration in inter-organizational networks (Grover and Kohli 2012). Therefore, value needs to be assessed by multilevel theorizing (Zhang and Gable 2017), including new network-level measures and metrics for assessing the distribution of value in the form of relational and spillover rents (Provan et al. 2007; Straub et al. 2004).

**Environment:** Environmental conditions can have a huge impact on how organizations can create business value from IT (Masli et al. 2011; Wong et al. 2012). First, characteristics of the economic region, such as availability of IT talent, technological infrastructure, and governmental support, shape the business value generation process (Shih et al. 2008; Zhu and Kraemer 2005). Second, industry characteristics, such as time-sensitivity and turbulence, can hinder or reinforce the extent to which organizations can create value from IT (Melville et al. 2004; Mithas et al. 2013). As IT is increasingly embedded in digital business capabilities, diverging technological prerequisites of countries and industries are even becoming more critical through the "digital divide" (Dewan and Riggins 2005). This thesis further emphasizes the critical role of environmental factors for IT business value generation. For instance, Study #5 demonstrates the moderating role of supply and demand uncertainties in the wood industry, and Study #1 that the impact of inter-organizational IT capabilities is greater in developing countries. Thus, industry and region characteristics need to be integrated in research on IT business value, either by including moderating factors or by investigating causal relationships in a specific context.

Overall, the proposed model of IT-based value co-creation (see Figure C-5) has been derived by following the three-step reference theorizing approach described in Section A.I.5. Following the recommendations of Grover and Lyytinen (2015), the centerpiece of this approach is to extend theory with the aim to increase the understanding of IT-related phenomena. Figure C-6 accounts for this focus by providing a more holistic view of the reference theorizing approach.

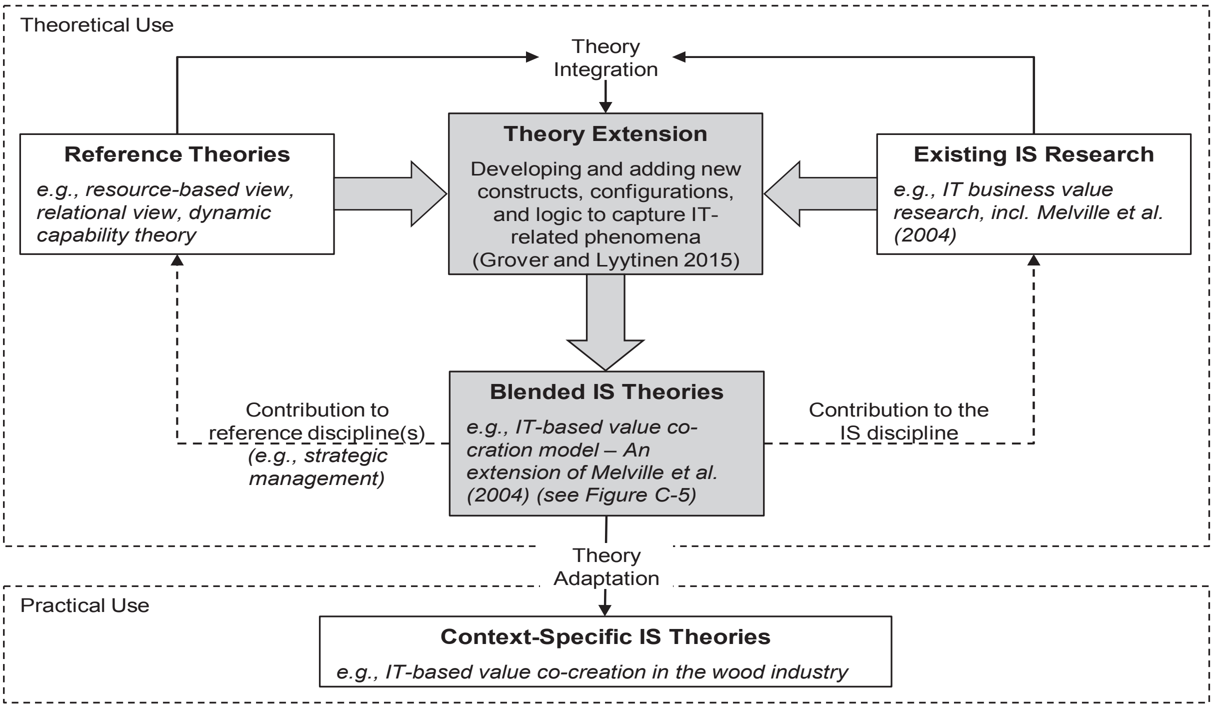


*Figure C-6. A holistic view of the reference theorizing approach*

Theory extension stems from both, theories from reference discipline(s) (e.g., the relational view from strategic management) and existing IS research (e.g., IT business value studies). It can be further informed by theory integration, e.g., through meta-analyses, as it provides basic building blocks for theory development (Hunter and Schmidt 2004). Building on these foundations, the reference theorizing approach used in this thesis involves two-way theory blending. This is in contrast to conventional reference theorizing which features one-way theory borrowing, i.e., solely instantiating or modifying reference theories to the IS context (Grover and Lyytinen 2015). Following such an advanced blending approach is reasoned by the fact that – though often taken for granted – reference theories are, in fact, not completely applicable for investigating IS-related issues (Avison and Malaurent 2014). Put simply, "the shoe does not fit" (Miller 2007, p. 180). Hence, proper reference theorizing should not only focus on transferring insights from one discipline to another (i.e., one-way influence), but also on generating novel theoretical insights that go beyond either discipline and contribute to both of them alike (i.e., two-way exchange) (see Section C.II.1). This is accomplished by accounting for dissimilarities between the involved disciplines, referred to as disanalogous and counterfactual reasoning (Oswick et al. 2011). For instance, this thesis shows that IOS as relation-specific assets per se do not create value, but that they need to be deeply embedded in digitized interfirm business processes. Ultimately, such a two-way theory blending approach leads to extended reference theories that properly capture IS-specific phenomena, i.e., blended IS theories. They are characterized by new constructs, configurations, and logic. The developed IT-based value co-creation model (see Figure C-5) is an example of such a blended IS theory. Beyond enriching traditional reference theorizing, blended IS theories may also serve as starting point for developing new and native IS theories, which are currently rare if not almost non-existent in IS research (see Section C.III.2).

Ultimately, while blended IS theories are characterized by a high level of abstraction, theory adaptation aims to instantiate and modify blended IS theories to a specific context. This offers the advantage of considering and understanding the contextual conditions that influence causal relationships while also increasing the practical relevance of the results (see Section C.II.2). While this thesis focused on the wood industry as an exemplary context, theory adaptation can be applied to other contexts as well, such as different economic sectors, countries, cultures, and network types. To summarize, a holistic view of reference theorizing is provided that is of both theoretical and practical use, thus contributing to latest IS calls to "Enrich the Mid-Range Theory" (Grover and Lyytinen 2015, p. 288).

To test the hypothesized relationships of the extended reference theories, the studies included in this thesis conducted large-scale quantitative analyses. The control variables, i.e., network and firm characteristics, did not influence the results. Besides, the inter-organizational IT capabilities could be instantiated to the context of the wood industry, substantiating the generalizability of the findings. Moreover, the adaptation of the findings to a specific industrial context provided additional insights on the underlying environment, i.e., the influence of environmental uncertainties as contextual factors and resource efficiency as a further value dimension. Consequently, the results provide solid empirical support for the proposed IT-based value co-creation model. Yet, future research should complement this primarily behavior-oriented perspective with design science research to further evaluate the findings (Hevner and Chatterjee 2010). The applicability and feasibility of the results can be verified by building and implementing solution-oriented IT artifacts (Hevner et al. 2004). For instance, prototypes for interfirm IT support and resource efficiency measurement instruments could be designed and evaluated within the scope of case studies in the wood industry. As such, the empirically supported findings of this thesis can be evaluated under real-life conditions to shed further light on their practical relevance and feasibility (Hevner et al. 2004).

## II. Implications for Research and Practice

In this section, the major contributions of this thesis for the relevant stakeholders are discussed. They include scholars in the fields of IS, strategic management, and operations management (Section C.II.1) as well as cross-industrial and wood industry-specific decision-makers who aim to realize benefits through inter-organizational IT investments (Section C.II.2).

### II.1 Implications for Research

The key implications of this thesis for research are summarized Table C-7.

*Table C-7. Overview of major research contributions*

| Community | Contribution | Explanation |
|---|---|---|
| Information Systems | (c1) Resolving contradictory findings on IT business value creation in inter-organizational networks by integrating previous research findings | Resource-based theories, i.e., the relational view and the dynamic capability theory, provide foundations to explain which inter-organizational IT factors lead to the co-creation of value. Contextual factors further add to explaining diverging results from previous research. |
| | (c2) Extending the relational view and dynamic capability theory to IS research in order to properly explain IT-based value co-creation mechanisms | The underlying constructs, configurations, and logic of the relational view and dynamic capability theory need to be extended to properly explain IT-related phenomena of value co-creation. This results in a hierarchical conceptualization of inter-organizational IT capabilities. |
| | (c3) Providing insights on IT-based value co-creation when considering the contextual conditions in a specific industry | The contextual conditions need to be considered when investigating IT-based value co-creation. In the wood industry, this relates to environmental uncertainties as contextual factors and to resource efficiency as additional business value dimension. |
| | (c4) Providing an IT-based value co-creation model that extends IT business value research | Extant theorizing on IT business value needs to be extended by incorporating an inter-organizational level of analysis, IT-embeddedness, information mindset, and expanded value dimensions. |
| | (c5) Offering a holistic view of reference theorizing with theory extension as its centerpiece to "Enrich the Mid-Range Theory" in IS research | The holistic view of the reference theorizing approach is of theoretical and practical use. Two-way theory blending contributes to both the reference disciplines(s) and the IS discipline. Practical use is increased by adapting blended IS theories to a specific context. |

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| | | |
|---|---|---|
| **Strategic Management** | (c6) Blending resource-based theories with existing IS research through disanalogous and counterfactual reasoning | Resource-based theories are not completely applicable to IS-specific phenomena. Dissimilarities between IOS and other inter-organizational resources, e.g., appropriation and indirect value effects, require new conceptualizations, configurations, and logic. |
| | (c7) Supporting the idea that the resource-based and industry structure perspective complement each other by integrating both perspectives | The resource-based perspective offers building blocks for theory development in order to explain IT-based value co-creation mechanisms. The industry structure perspective provides theoretical foundations to investigate the contextual conditions of how inter-organizational networks can achieve competitive advantage. |
| **Operations Management** | (c8) Integrating IT capabilities into research on value creation through resource efficiency | IT capabilities, especially IT alignment as dynamic capability, inform the understanding of how to achieve resource efficient production. |
| | (c9) Offering a conceptual model and measurement instrument to capture resource efficient production in quantitative research | To conceptualize and measure resource efficient production, it is viewed as a multi-dimensional construct, including input materials, production processes, output products, and logistics processes as sub-dimensions. |

The very first major contribution of this thesis to IS literature lies in resolving contradictory and inconsistent findings of previous research on IT business value creation in inter-organizational networks (c1). So far, both the relationship between inter-organizational IT factors and business value (e.g., Sabherwal and Jeyaraj 2015; Saldanha et al. 2013) as well as the effect of IT on organizational agility (e.g., Gosain et al. 2004; Overby et al. 2006) showed mixed results and inconsistencies, limiting the understanding of inter-organizational IT business value generation. This thesis, by contrast, emphasizes the critical role of reference theories and contextual factors for theorizing, both of which have been found to be important factors in explaining diverging results from previous research. This finding provides a starting point for future studies by informing IS researchers on how theoretical conceptualizations and contextual factors can influence their findings. For instance, researchers should take account of conceptualizing IT factors as capabilities, considering the studied region and type of relationship, utilizing objective measures carefully, and analyzing business value at multiple levels of analysis. Moreover, by adopting resource-based reference theories, researchers may be able to provide insights for future theory development in the field of IT-based value co-creation.

Another major contribution of this thesis is theory extension, in particular the blending of resource-based theories with existing IS research (c2 and c6). Since resource-based theories are not completely applicable to IS-specific phenomena, the findings extend theory by consistently embedding the IT artifact into context, and by developing and adding new constructs, configurations, and logic that properly explain IS-related phenomena of business value creation. Disanalogous and counterfactual reasoning (Oswick et al. 2011) has been adopted to account for the dissimilarities between the reference discipline and the IS discipline. For instance, one dissimilarity stems from the concept of appropriation (Subramani 2004), i.e., the use of IS in the same context can lead to divergent outcomes. In the context of inter-organizational networks, specifically, IOS can both be conceptualized as a network resource and as an enabler of relational mechanisms (Grover and Kohli 2012). Besides, another dissimilarity between IS and other relation-specific assets is the fact that IS assets per se do not directly lead to competitive advantage (Wade and Hulland 2004). Overall, both special characteristics of IS provide the foundation for theory extension. Regarding the relational view, this thesis has introduced IT-enabled integration as a new construct, on the one hand, and the differentiation between information processing and digitally enabled interfirm capabilities as a new conceptual configuration, on the other hand. The dynamic capability theory, in turn, has been extended by blending it with the distinction of higher- and lower-order capabilities known from IS research (Rai et al. 2006). This has resulted in inter-organizational IT alignment as a novel construct, and in a new logic, i.e., the relationship of alignment with inter-organizational IT capabilities and relational value. Both extended theories show that – in contrast to the respective reference theory – not all IT-related capabilities contribute directly to relational value, and that a hierarchy of IT-based value co-creation mechanisms needs to be conceptualized. This finding extends the understanding of how value can be co-created through IT, and thus how inter-organizational networks can achieve competitive advantage. Accordingly, this thesis contributes to both the IS community (c2) as well the reference discipline of strategic management (c6).

Furthermore, this thesis offers the IS community insights in terms of the importance of contextual conditions that influence IT-based value co-creation in inter-organizational networks (c3). In the specific context of supply chains in the wood industry, environmental conditions and different business value dimensions have been found to be considerable contextual conditions when analyzing the impact of IT on value. First, previous research found mixed results regarding the role of environmental uncertainties for achieving performance (Wong et al. 2011). The results of this thesis yet show that supply and demand uncertainties, in contrast to technological and product uncertainties, are of particular relevance in the wood industry. Second, the question of whether resource efficiency has a positive impact on performance outcomes continues to be a controversial issue in OM research (Adler et al. 2009). Yet, the results of this thesis outline the important role of resource efficient production in the wood industry. In sum, both findings indicate that the underlying industry as a contextual condition can provide additional insights on how IT can co-create value. This thesis, thus, also contributes to IS research calls for focusing more on contextual factors (e.g., Chiasson and Davidson 2005; Melville et al. 2004; Venkatesh 2013).

Beyond the contributions of this thesis to the particular research stream of IT-based value co-creation, this thesis also extends theory on IT business value in general (c4) (see Figure C-5). It thus directly contributes to the four research themes that are considered critical to IS research by Kohli and Grover (2008): First, this thesis extends the level of analysis to the inter-organizational level in order to show how companies with different IT resources can jointly create business value (Theme 1). Second, digital business capabilities are identified as the main driver of business and relational value by embedding IT into context (Theme 2). Third, this thesis addresses the topic of information mindset (Theme 3) by utilizing the notion of information capabilities and by examining their relation to digital business capabilities. Fourth, value is expanded (Theme 4) by incorporating organizational agility and resource efficiency as additional value dimensions. Altogether, these findings have been integrated into a model of IT-based value co-creation (see Figure C-5) that extends current theorizing in research on IT business value (e.g., Kohli and Grover 2008; Masli et al. 2011; Melville et al. 2004; Schryen 2013).

Moreover, this thesis offers the IS community a holistic view of reference theorizing (c5) (see Figure C-6). With theory extension as its centerpiece, this view expands on the advanced approach of two-way theory blending in contrast to the conventional approach of one-way theory borrowing (Grover and Lyytinen 2015; Oswick et al. 2011). On the one hand, this advanced approach leads to richer theoretical insights by contributing both to the reference discipline(s) and the IS discipline. On the other hand, practical use is increased by adapting blended IS theories to a specific context at a lower level of abstraction. Overall, such an holistic view of the applied reference theorizing approach contributes to "Enrich the Mid-Range Theory" (Grover and Lyytinen 2015, p. 288) in IS research. It can be adopted by IS scholars to investigate further IT business value topics, e.g., in other industries, as well as to examine other research fields.

A further contribution to the strategic management literature lies in the integration of the resource-based and industry structure perspective (c7). While both perspectives evolved independently in the past, and were even regarded as competing views (Duhan et al. 2001), this thesis supports the emergent view that both perspectives complement each other (e.g., Ortega 2010; Spanos and Lioukas 2001). On the one hand, this thesis has adapted the resource-based perspective to develop and conceptualize IT factors as sources of co-created value. In fact, the results indicate that inter-organizational resources in form of IT capabilities explain how inter-organizational networks co-create value, and thus how they achieve competitive advantage. On the other hand, the results also suggest that the underlying industry represents an important contextual condition under which value can be co-created. Therefore, it is concluded that organizations can achieve superior performance outcomes by following an industry leading strategy that addresses challenges arising from their specific sector. Overall, the results of this thesis hence support latest research impulses to integrate the resource-based and industry-structure perspective by showing that organizations in the wood industry outperform their competitors with the utilization of IOS if they achieve a high level of resource efficiency and address environmental uncertainties of supply and demand.

By investigating IT-based value co-creation in the specific context of the wood industry, the findings of this thesis also offer contributions to the field of operations management (c8 and c9). First, while previous OM research has widely examined the performance-enhancing impact of resource efficiency (Adler et al. 2009), the role of IT for achieving resource efficiency has scarcely been investigated (Ayabakan et al. 2017). This thesis integrates the notion of IT capabilities into the process of value creation through resource efficiency. More specifically, the findings reveal that IT alignment as a dynamic capability is an important explanatory factor of and mediator to resource efficient production. The results thus highlight the important role of IT for achieving resource efficiency in manufacturing firms in general and in wood processing companies in particular. Second, this thesis has developed a multi-dimensional measurement construct for resource efficient production, including input materials, production processes, output products, and logistics processes as sub-dimensions. This conceptualization broadens the theoretical interpretation of resource efficient production, and can hence contribute to a more profound and consistent understanding in literature (Huysman et al. 2015). In previous studies, resource efficiency was captured with objective measures, usually by collecting data from secondary sources (e.g., Ayabakan et al. 2017; Modi and Mishra 2011). While this approach provides a high reliability, perceptual measures are regarded to better suit the context of a study (Chau et al. 2007). It is especially difficult to quantify IT capabilities and their outcomes with objective measures (Kohli and Grover 2008). Accordingly, the measurement instrument developed in this thesis, including 18 questionnaire items, can set the stage for future IS and OM research on additional antecedents and outcomes of resource efficient production. To sum up, this thesis makes a further step in the "nexus" (Venkatesh 2013) of the IS and OM literature.

## II.2 Implications for Practice

Ensuring the practical relevance of research findings corresponds with the ongoing debate of "rigor and relevance" in IS research (e.g., Lee 1999; Straub and Ang 2011). The reference theorizing approach applied in this thesis has thus also been followed with the intention to increase the practical relevance of the results. Apart from allowing to derive implications from the cross-industrial studies, this approach also accounts for adapting theoretical insights to the specific context of the wood industry. This approach thus increases the practical relevance by addressing real-life business problems in general, and by targeting a specific audience in particular (Robey and Markus 1998; Rosemann and Vessey 2008), as well as by considering special characteristics of the underlying context (Grover and Lyytinen 2015). As a matter of course, the findings are theoretically founded as well. Consequently, this thesis provides both cross-industrial managerial implications for organizations cooperating in inter-organizational networks as well as contributions specifically directed to organizations in the wood industry. The implications for practice are summarized in Figure C-7, and are detailed as follows.

In general, this thesis offers valuable insights for managers who aim to realize superior benefits by making joint investments in IT with their network partners. An overarching finding across the studies is that business value in terms of relational rents and organizational agility results from developing IT capabilities rather than making IOS investments per se. Accordingly, managers should foster the development of unique inter-organizational IT capabilities instead of solely focusing on IT investments to derive superior benefits. Moreover, the results indicate that the value of IOS results primarily from higher-order, digitized inter-organizational IT capabilities in contrast to information processing capabilities. Therefore, the results inform practitioners about the particular type of IT capabilities that impacts performance the most and the strategic potential of their inter-organizational IT investments. Accordingly, guidance is given on how scarce resources should be allocated across information processing, digitally enabled, and dynamic capabilities. IT and business executives responsible for interfirm relationships should primarily focus on IT investments that support interfirm business activities, i.e., by exploiting existing competencies, exploring new business opportunities, and developing dynamic IT capabilities. Although information processing capabilities provide an important foundation for these purposes, investments in these capabilities should be carefully evaluated regarding their contribution to higher-order inter-organizational IT capabilities. For example, an integrated IT infrastructure was important to Dell in the 1990s to effectively coordinate with its suppliers and to pursue a strategy of direct sales and mass customization (Fields 2003; Kraemer et al. 2000). In the end, its performance in terms of short inventory cycles and its outstanding competitive position yet ultimately resulted from improved inter-organizational build-to-order processes (i.e., digitally enabled interfirm capability), which were appropriately supported by supply chain management and e-commerce systems (i.e., IT alignment).

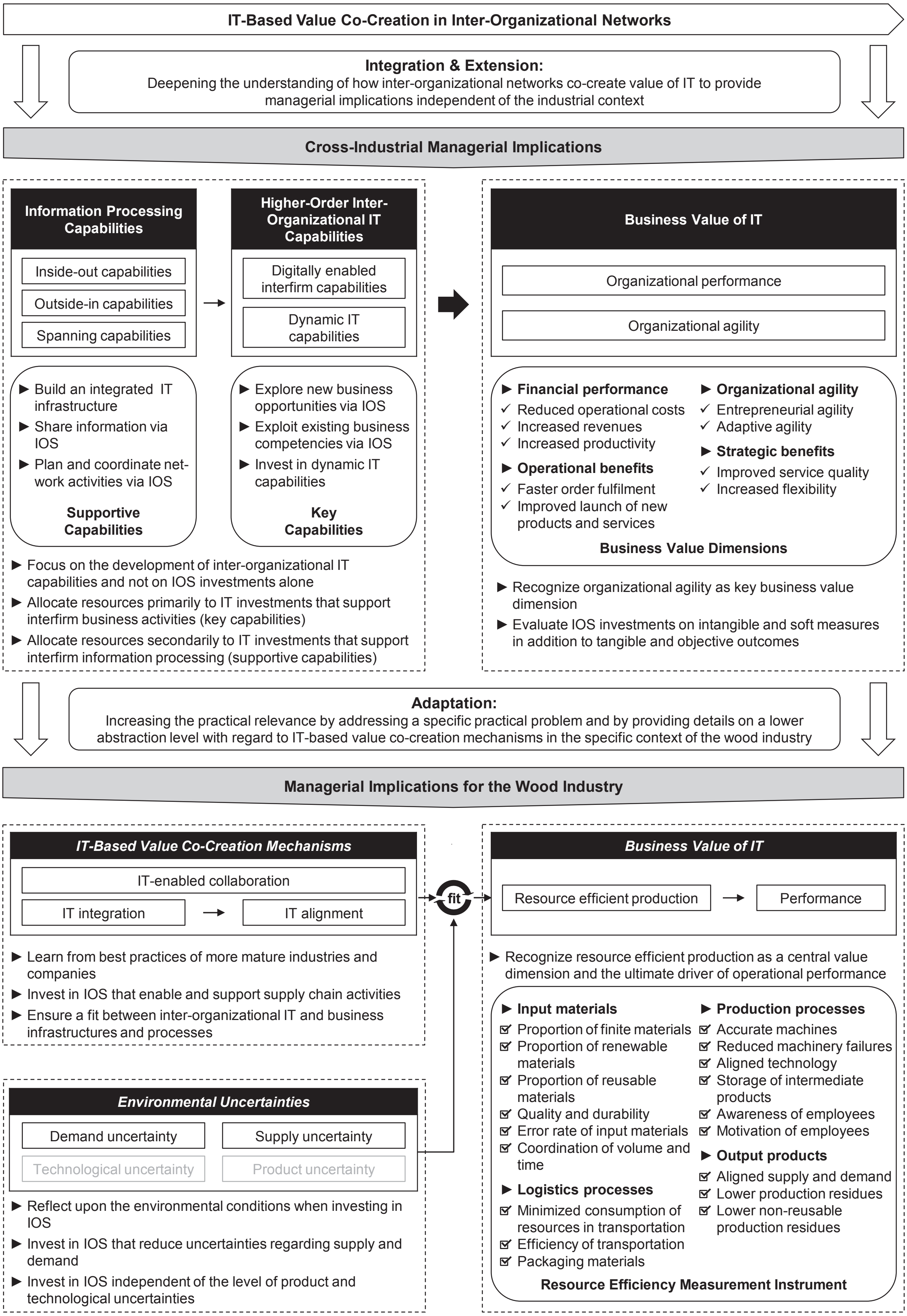


*Figure C-7. Overview of major implications for practice*

Next, this thesis gives some insights to managers on evaluating performance outcomes derived from cooperating in inter-organizational networks. First, decision-makers should be aware that organizational agility is an important outcome of IT investments. Therefore, they should also reflect upon possible environmental changes when evaluating the success of IOS investments, for example, by conducting forecasts (Tallon and Pinsonneault 2011). Second, IT executives should not only evaluate IOS investments by means of tangible and objective measures, but should also consider intangible and soft business value dimensions.

Furthermore, this thesis provides recommendations to decision-makers involved in networks in the wood industry on deriving value from IT investments. On the one hand, the results show that the theoretically developed causal explanations for IT-based value co-creation also hold true in the specific context of the wood industry. Accordingly, IT executives in this sector can – to some extent – learn from experiences and adapt best practices from more mature industries, such as the banking industry. The results additionally inform managers on specific IT capabilities that should be developed, i.e., IT-enabled collaboration and IT alignment. On the other hand, the results highlight that decision-makers need to carefully reflect upon the contextual conditions when investing in IOS. In particular, managers should pay more attention to IT investments that reduce environmental uncertainties in demand and supply since they are more likely to pay off. Though, IOS investments should be made independently from product and technological uncertainties, irrespective of the level of environmental turbulence.

Finally, this thesis targets practitioners in the wood industry by developing a resource efficiency measurement instrument, and examining the role of this construct in the IT value creation process. First, the results provide empirical evidence that resource efficient production can explain a substantial amount of operational performance. As such, managers in the wood industry should recognize resource efficiency as a central business value dimension and the ultimate driver of operational benefits. Second, the multi-dimensional and detailed conceptualization of resource efficiency, including input materials, production processes, output products, and logistics processes, provides managers with a useful indication of the types of actions they should take to increase the level of resource efficiency. For instance, companies can invest in technological improvements within the production process (Neugebauer et al. 2011), and provide training to enhance the skills, awareness, and motivation of workers regarding resource savings (Veleva and Ellenbecker 2001). Third, the developed construct can support executives in the identification and quantification of the level of resource efficiency in their company. For identification, the underlying dimensions and item stems can be used as a checklist since they include the relevant aspects of resource efficient production in a manufacturing firm. Regarding quantification, the construct provides a starting point for selecting or developing further quantifiable indicators. Examples include the percentage of new material content (Bach et al. 2016) and recyclability rates of products (Ardente and Mathieux 2014). In the end, the thesis' practical relevance is further underlined by the interest and participation of the over 750 companies in the conducted surveys. The respondents mainly ascribed to the level of managing directors.

# III. Concluding Remarks

Collaborating in inter-organizational networks is becoming increasingly important for companies across industries, with IT being regarded an integral part of collaboration. However, firms still often fail to realize value from IT investments, especially since the inter-organizational context makes the circumstances even more difficult. This is particularly relevant in the wood industry, in which organizations closely cooperate, also with the help of IT, in order to increase the efficient use of resources and to meet environmental uncertainties. Accordingly, this thesis has aimed to advance the understanding of IT-based value co-creation in inter-organizational networks by conducting six empirical studies, including more than 41,000 observations in quantitative studies, ten expert interviews, and over 750 collected questionnaires. By following a reference theorizing approach, theories were integrated, extended, and adapted to properly advance research on IT business value generation in inter-organizational networks. In essence, the findings reveal that IS have specific value creation mechanisms that are reflected in a hierarchy of IT capabilities. Moreover, special contextual conditions of the wood industry, namely environmental uncertainties and a need for realizing resource efficiency must be considered when applying these insights. Hence, this thesis contributes to research by extending theory on IT business value generation to an inter-organizational level of analysis, and offering new theoretical insights on causal relationships. Moreover, it contributes to practice by providing recommendations for investing in inter-organizational IT and for evaluating the resulting payoffs.

## III.1 Limitations

As with all research, it is important to consider the limitations of this dissertation when interpreting its results. First of all, this cumulative thesis includes cross-sectional studies that have been conducted at a single point of time. Though cross-sectional studies represent a common approach in IT business value research (Sabherwal and Jeyaraj 2015), their results should be treated with caution as causality cannot be directly concluded from cross-sectional, non-longitudinal data (Pavlou and El Sawy 2006). Moreover, it has been shown that IT business value generation is influenced by time lag effects (Santhanam and Hartono 2003). This might especially be the case where the effects of improved dynamic capabilities need time to impact organizational agility and are affected by environmental changes (Tallon and Pinsonneault 2011). While a longitudinal analysis could provide valuable insights into such dynamics, it is first necessary to establish solid cross-sectional models before investigating their development over time (Pavlou and El Sawy 2006).

Furthermore, the interpretability of the results can be affected by biases and characteristics of the employed research methodologies. First, Studies #1 and #2 used meta-analysis techniques, which only allow analyzing quantitative studies. This could bear the risk of sampling bias (King and He 2006). While Studies #3 and #4 confirmed the applicability of the results, future research could confirm and enrich the findings by integrating them with studies employing non-quantitative methods. Second, all quantitative empirical studies included in this thesis (i.e., #3, #4, #5, and #6) employed a single-informant approach, which may result in common method variance. Both, ex ante measures, i.e., carefully developing the measurement instruments and the questionnaire, and ex post analysis, i.e., Harman's single factor test and marker variable analysis, aimed to minimize CMV (Podsakoff et al. 2003). More importantly, the studies did not aim to simply find high correlations between the variables, but to demonstrate how they interrelate in a structural model regarding mediation and moderation. However, the results need to be interpreted with caution as all indicators were measured with perceptual data. While the networked level of analysis and cross-sectional design did not allow the use of archival data, collecting objective performance data in single firms could be attempted by future research to improve the reliability of the results. Finally, limitations regarding the construct development of resource efficient production should be noted. It should be acknowledged that no psychometric measure can completely capture every aspect of a phenomenon as complex as resource efficiency (Segars and Grover 1998). While a rigorous methodological approach, including literature analysis, expert interviews and validation, and statistical analyses, has been adopted to ensure the adequacy of measurement, future research should further replicate and extend the developed construct.

Lastly, this thesis follows a positivistic approach with the aim to explain and predict how inter-organizational networks co-create business value with IT. Consequently, other factors and consequences of value creation in inter-organizational networks have not been prioritized though they may exist as well. First, it should be noted that IT utilization in inter-organizational networks may also result in negative effects on business value. For instance, large investments in inappropriate systems and high levels of alignment may hinder the adaptability to environmental changes by causing rigidity-traps (Tallon and Pinsonneault 2011), and high relation-specific investments in integrated systems may lead to the risk of lock-in effects (Saraf et al. 2007). While the meta-analyses showed that negative effects are outperformed by the enabling role of IT, future research should also explore possible negative effects, tensions, and paradoxes to extend the findings of this thesis. Second, non-IT related factors, such as network characteristics (e.g., Morgan and Hunt 1994) and organizational resources and capabilities (e.g., Rai et al. 2006), influence value creation in inter-organizational networks. While a major contribution of this thesis lies in examining IT-specific phenomena of value co-creation and embedding IT into context, future research can enrich the findings by exploring the interactions and interdependencies of these IT-based value co-creation mechanisms with non-IT related factors.

## III.2 Future Research Directions

The findings of this cumulative thesis provide a number of directions for future research. First of all, the studies included in this thesis mainly analyze value co-creation at the relationship level from the perspective of a single firm. Although analyses at the network level would be desirable, this approach represents a challenging task in organizational science (Provan et al. 2007), and is also rarely examined in the field of IT-based value co-creation (Mandrella et al. 2016). Research on whole networks requires the development of completely new measurement instruments and metrics (Straub et al. 2004). So far, only a few studies utilized such measures in IS research (e.g., Han et al. 2012; Lim and Melville 2012). Moreover, multilevel theorizing, including complex mathematical operations to capture network-level phenomena, will be necessary (Zhang and Gable 2017). Social network measures may be a possible solution (Newman 2003). Consequently, research at the network level represents a challenging future research direction, which, however, would provide several benefits in terms of deepening the understanding on how value can be co-created through IT. According to the composition of relational rents (see Figure A-5), this thesis primarily focused on internal and appropriated relational rents. Investigations at the network level would be beneficial to the analysis of inbound and outbound spillover effects, and therefore to the distribution and sharing of relational rents among network members (Lavie 2006). Furthermore, it would lead to a better understanding of the generation of collective outcomes and the differentiation of whole networks in their IT capabilities and the resulting value (Provan et al. 2007). Lastly, the structural position of a single firm within the network and how it contributes to and benefits from network-level outcomes can be assessed through multilevel theorizing and analysis (Zhang and Gable 2017).

Next, the wood industry has been exemplarily chosen in this thesis for adapting theory to a specific context. Future research can extend the findings by either analyzing this industry in more detail or adapting the findings to other contexts. Regarding the wood industry, it should be acknowledged that its subsectors might differ in their contextual conditions (Zander 2017). For example, the pulp and paper industry displays higher IT adoption rates than other wood-related subsectors (Hewitt et al. 2011). The findings of this thesis indicate that the causal relationships of value co-creation hold true for different subsectors. Nevertheless, future research can analyze how specific contextual conditions within the subsectors additionally affect IT-based value co-creation regarding contextual factors and further business value dimensions. Moreover, further studies can be conducted to analyze IT-based value co-creation in different contexts. For example, value can be co-created in platform ecosystems by leveraging digital platform capabilities and dynamic capabilities (Karimi and Walter 2015). In this regard, researchers may reveal promising insights on new dynamics in IT-based collaboration (Tilson et al. 2010). Such studies in other contexts would provide additional insights on the studied phenomenon, while also increasing the practical relevance of the findings.

Finally, this thesis applied a reference theorizing approach that contributes to "mid-range" theorizing in IS research (Grover and Lyytinen 2015). Future studies should also expand research on IT-based value co-creation to the left edge, i.e., data-driven research, and the right edge of theorizing, i.e., Blue Ocean theorizing (Goes 2015). On the one hand, data-driven research involves rigorous empirical research that aims to discover important and unexpected findings by collecting and analyzing new data (Avison and Malaurent 2014). As this research is conducted without pre-existing theories in mind, it provides the foundation for future theory development (Hambrick 2007). For instance, in-depth case studies within one or a few inter-organizational networks could be conducted to derive behavior patterns between network partners regarding the utilization of IS and the effectiveness of success metrics. This could, for example, provide the foundation for multilevel theorizing at the network-level of analysis. On the other hand, the development of original, native IS theories is still rare to non-existent (Grover and Lyytinen 2015; Straub 2012). Blue Ocean theorizing involves the development of novel theories and breakthrough ideas (Straub 2009). This thesis indicates that causal relationships in inter-organizational networks are specific in the IS context. The resulting reconfiguration of well-established constructs and relationships can provide a starting point for richer theory development (Lamb et al. 2003; Ragu-Nathan et al. 2008). However, both approaches require a shift in mindset in the IS community (Grover and Lyytinen 2015). Reviewing practices, editorial policies, doctoral programs, and individual academic behaviors need to include a greater variety of both theorizing and empirical approaches. By fostering a greater diversity of contributions, IS scholars will not only advance the understanding of IT-based value co-creation, but will also contribute important knowledge on IT-related phenomena in light of contemporary developments.

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# Appendix

## Appendix A. Overview of the authors' contribution in the studies included in this thesis.

| No | Section | Title | Author | Authors' contribution |
|---|---|---|---|---|
| #1 | B.I | Synthesizing and Integrating Research on IT-Based Value Co-Creation: A Meta-Analysis | **Markus Mandrella** | **60 %** |
| | | | Simon Trang | 30 % |
| | | | Lutz M. Kolbe | 10 % |
| #2 | B.I | Diving into the Relationship of Information Technology and Organizational Agility: A Meta-Analysis | Daniel Leonhardt | 50 % |
| | | | **Markus Mandrella** | **45 %** |
| | | | Lutz M. Kolbe | 5 % |
| #3 | B.II | IT-Based Value Co-Creation: A Reconceptualization and Extension of the Relational View | **Markus Mandrella** | **60 %** |
| | | | Simon Trang | 15 % |
| | | | Sebastian Zander | 15 % |
| | | | Lutz M. Kolbe | 10 % |
| #4 | B.II | The Role of Inter-Organizational IT Alignment for Co-Creating Value: Empirical Evidence from Regional Network Collaborations | Simon Trang | 40 % |
| | | | **Markus Mandrella** | **40 %** |
| | | | Mauricio Marrone | 10 % |
| | | | Lutz M. Kolbe | 10 % |
| #5 | B.III | Shifting from Justification to Understanding: The Impact of Environmental Uncertainty on the Value of IT-Enabled Collaboration in Supply Chains | Sebastian Zander | 50 % |
| | | | **Markus Mandrella** | **40 %** |
| | | | Lutz M. Kolbe | 10 % |
| #6 | B.III | Creating Value through IT-Enabled Resource Efficient Production: A Dynamic Capability Perspective | **Markus Mandrella** | **70 %** |
| | | | Sebastian Zander | 20 % |
| | | | Lutz M. Kolbe | 10 % |

*Note: Authors are listed in the order as they appear in the original publication.*

## Appendix B. Overview of the author's published and forthcoming articles as of October 2017.

| Authors | Publication | Ranking | Status |
|---|---|---|---|
| **Journal Contributions (peer reviewed)** | | | |
| **Mandrella, M.;** Trang, S.; Kol-be, L. M. | Synthesizing and Integrating Research on IT-Based Value Co-Creation: A Meta-Analysis, *Journal of the Association of Information Systems (JAIS)*. * | A | Passed 1st round of re-view |
| Trang, S.; **Mandrella, M.**; Kolbe, L. M. | The Role of Inter-Organizational IT Alignment for Co-Creating Value: Empirical Evidence from Regional Net-work Collaborations, *Journal of Information Technology (JIT)*. * | A | 2nd round of review |
| **Mandrella, M.**; Trang, S.; Zander, S.; Kol-be, L. M. | IT-Based Value Co-Creation: A Reconceptualization and Extension of the Relational View, *Information and Organi-zation*. * | B | Submitted |
| **Conference Contributions (peer reviewed)** | | | |
| **Mandrella, M.**; Zander, S.; Kol-be, L M. | Creating Value through IT-Enabled Resource Efficient Production: A Dynamic Capability Perspective, *Proceed-ings of the Pacific Asian Conference on Information Sys-tems (PACIS) 2017*, Langkawi, Malaysia. * | C | Published |
| Leonhardt, D.; **Mandrella, M.**; Kolbe, L. M. | Diving into the Relationship of Information Technology and Organizational Agility: A Meta-Analysis, *Proceedings of the International Conference on Information Systems (ICIS) 2016*, Dublin, Ireland. * | A | Published |
| **Mandrella, M.;** Trang, S.; Kol-be, L. M. | Synthesizing and Integrating Research on IT-Based Value Co-Creation: A Meta-Analysis, *Proceedings of the Euro-pean Conference on Information Systems (ECIS) 2016*, Istanbul, Turkey. * | B | Published |
| Zander, S.; **Mandrella, M.**; Kolbe, L. M. | Shifting from Justification to Understanding: The Impact of Environmental Uncertainty on the Value of IT-Enabled Collaboration in Supply Chains, *Proceedings of the Euro-pean Conference on Information Systems (ECIS) 2016*, Istanbul, Turkey. * | B | Published |
| **Mandrella, M.**; Zander, S.; Trang, S. | How Different Types of IS Assets Account for Synergy-Enabled Value in Multi-Unit Firms: Mapping of Critical Success Factors and Key Performance Indicators, *Proceed-ings of the Americas Conference on Information Systems (AMCIS) 2016*, San Diego, USA. | D | Published |
| Zander, S.; **Mandrella, M.**; Marrone, M.; Kolbe L. M. | Value Co-Creation in Supply Chains through IT Integra-tion: The Role of Collaborative Network Structure, *Pro-ceedings of the Americas Conference on Information Sys-tems (AMCIS) 2016*, San Diego, USA. | D | Published |
| Brendel, A. B; **Mandrella, M.** | Information Systems in the Context of Sustainable Mobili-ty Services: A Literature Review and Directions for Future Research, *Proceedings of the Americas Conference on Information Systems (AMCIS) 2016*, San Diego, USA. | D | Published |
| **Mandrella, M.**; Zander, S.; Kol-be, L. M. | IT-Based Value Co-Creation: A Literature Review and Directions for Future Research, *Proceedings of the Hawaii International Conference on System Sciences (HICSS) 2016*, Kauai, Hawaii, USA. | C | Published |
| Zander, S.; Trang, S.; **Mandrella, M.**; Marrone, M.; Kolbe, L. M. | Integrating Industry Characteristics in Interorganizational IS Adoption Models: A Mixed Method Approach, *Pro-ceedings of the Pacific Asian Conference on Information Systems (PACIS) 2015*, Singapore. | C | Published |

*Continued on Page 240*

*Continued from Page 239*

| | | | |
|---|---|---|---|
| Trang, S.; **Mandrella, M.**; Zander, S.; Hildebrandt, B.; Kolbe, L. M. | Value Co-Creation through Network IT Alignment: An Empirical Examination in Regional Networks, *Proceedings of the Americas Conference on Information Systems (AMCIS) 2015*, San Juan, Puerto Rico. | D | Published |
| **Mandrella, M.**; Trang, S.; Zander, S.; Kolbe, L. M. | Influence of Network Characteristics on Inter-Organizational IT Integration: The Role of Commitment and Trust, *Proceedings of the Americas Conference on Information Systems (AMCIS) 2015*, San Juan, Puerto Rico. | D | Published |

*Note: The ranking is based on the VHB Jourqual 3 ranking; * Indicates that the study is included in this cumulative dissertation.*

## Appendix C. Overview of the author's conference presentations as of October 2017.

| Conference | Presentation Title |
|---|---|
| Pacific Asia Conference on Information Systems (PACIS) 2017 *Langkawi, Malaysia* | Creating Value through IT-Enabled Resource Efficient Production: A Dynamic Capability Perspective. |
| International Conference on Information Systems (ICIS) 2016 *Dublin, Ireland* | Diving into the Relationship of Information Technology and Organizational Agility: A Meta-Analysis. |
| Americas Conference on Information Systems (AMCIS) 2016 *San Diego, USA* | How Different Types of IS Assets Account for Synergy-Enabled Value in Multi-Unit Firms: Mapping of Critical Success Factors and Key Performance Indicators. |
| Americas Conference on Information Systems (AMCIS) 2016 *San Diego, USA* | Information Systems in the Context of Sustainable Mobility Services: A Literature Review and Directions for Future Research. |
| European Conference on Information Systems (ECIS) 2016 *Istanbul, Turkey* | Synthesizing and Integrating Research on IT-Based Value Co-Creation: A Meta-Analysis. |
| Global Cleaner Production & Sustainable Consumption Conference (GCPC) 2015 *Sitges, Spain* | IT-Based Value Co-Creation in Inter-Organizational Networks for the Utilization of Renewable Resources. |
| Hawaii Conference on System Sciences (HICSS) 2016 *Kauai, Hawaii, USA* | IT-Based Value Co-Creation: A Literature Review and Directions for Future Research. |
| Americas Conference on Information Systems (AMCIS) 2015 *Fajardo, Puerto Rico* | Influence of Network Characteristics on Inter-Organizational IT Integration: The Role of Commitment and Trust. |

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