SERVICE-ORIENTED ARCHITECTURE (SOA):

AN EMPIRICAL EVALUATION OF CHARACTERISTICS, ADOPTION DETERMINANTS, GOVERNANCE MECHANISMS, AND BUSINESS IMPACT IN THE GERMAN SERVICE INDUSTRY

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Dedicated to my family

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Zusammenfassung

Seit der ersten Verwendung des Begriffs „Serviceorientierte Architektur“ (SOA) durch Analysten von Gartner im Jahr 1996 (Schulte 1996; Schulte and Natis 1996) wurde die Idee der Serviceorientierung bei der Gestaltung der Architektur von Informationssystemen und unterstützenden Informationstechnologien (IT) sowohl in der Wirtschaft als auch in der Forschung zunehmend verfolgt (Mathiassen and Sorensen 2008; Papazoglou and Heuvel 2007; Papazoglou et al. 2008; Viering et al. 2009). Dabei nutzt SOA die Prinzipien der Objekt- und der Komponentenorientierung, um nicht nur einzelne Systeme sondern ganze Systemlandschaften zu gestalten (Siedersleben 2007). In den letzten Jahren sind zahlreiche Definitionen für SOA erschienen, welche die Reichweite des Begriffs unterschiedlich abgrenzen (Erickson and Siau 2008). So findet sich in der Literatur ein Kontinuum von sehr engen Definitionen, die SOA auf die Entwicklung von Anwendungssystemen beschränken (Krafzig et al. 2005), bis hin zu Definitionen, die auch die Gestaltung der Organisationsstruktur beinhalten (Bieberstein et al. 2005a).

Während die ersten Forschungsarbeiten zu SOA primär die technischen Aspekte zur Implementierung einer SOA untersuchten (Viering et al. 2009), wurde in der jüngeren Literatur der Ruf nach der Analyse der organisatorischen Auswirkungen laut (Ren and Lyytinen 2008; Vitharana et al. 2007; Zhao et al. 2008). Dem Ruf wurde jedoch bisher nur unzureichend gefolgt (Viering et al. 2009). Die vorliegende Dissertation nimmt sich diesem wichtigen Thema an. Sie wendet eine ganzheitliche Sichtweise auf SOA über alle Ebenen der gesamten Unternehmensarchitektur an. Vereint werden sowohl die technischen als auch die organisatorischen Aspekte, um die wechselseitigen Beziehungen zwischen der Einführung von SOA und dem adoptierenden Unternehmen zu untersuchen. Dabei werden konkret folgende drei Forschungsrichtungen verfolgt:

- Adoption: Warum und unter welchen Umständen führen Unternehmen SOA ein?
- Auswirkung auf Unternehmen: Was sind die Vorteile, die aus einer Einführung von SOA resultieren?
- Governance: Wie sollten die Einführung und das Management von SOA ausgestaltet sein, um die Vorteile zu erreichen?

Zur Beantwortung dieser Fragen wird in dieser Dissertation ein empirisch-quantitatives Vorgehen gewählt. Den Einstieg in die Studie stellte eine Literaturrecherche dar, die den bisherigen Stand des Wissens zusammengeführt und die konkreten Forschungsfragen motiviert hat. Anschließend wurden neun Fallstudien in der deutschen Dienstleistungswirtschaft durchgeführt, um die Forschungsfragen weiter zu detaillieren und die konzeptuellen Modelle zu verfeinern. Darauf aufbauend wurden für das quantitative Vorgehen zunächst geeignete Messmodelle für den Grad der Adoption von SOA sowie zur Messung des Reifegrades einer in einem Unternehmen implementierten SOA entwickelt. Auf Basis dieser Vorarbeiten wurden die einzelnen Forschungsmodelle, die auf unterschiedlichen theoretischen Ansätzen basieren – wie der Modular Systems Theory, der Dynamic Capabilities Theory oder dem Technology-Organization-Environment (TOE) Framework –, mit Hilfe von quantitativen Methoden, insbesondere der Strukturgleichungsmodellierung, getestet. Dazu wurden Daten von 247 Unternehmen der deutschen Dienstleistungswirtschaft erhoben.

Die Ergebnisse der Untersuchungen sind in acht, teils veröffentlichten und teils zur Begutachtung bei internationalen Zeitschriften eingereichten Artikeln dokumentiert.

Die Ergebnisse der Arbeit zeigen, dass fünf verschiedene Strategien für die Adoption von SOA identifiziert werden können. Diese reichen von gar keiner Adoption bis zur Serviceorientierung der gesamten Unternehmensarchitektur über alle Ebenen hinweg. Besonders wichtig für eine möglichst weitreichende Adoption sind unternehmensinterne Faktoren, wie IT-Fachkenntnisse, Unterstützung der Unternehmensführung und Kompatibilität des SOA-Paradigmas zu den eigenen IT-Gegebenheiten. Weitere Faktoren, die die umfassende Einführung von SOA beeinflussen, sind der relative Vorteil von SOA, die Kosten und die Unternehmensgröße. Bemerkenswerterweise wird die Komplexität von SOA nur als Kostentreiber, nicht jedoch als direkter Einflussfaktor für die Adoption gesehen. Außerdem zeigen die Ergebnisse, dass die Adoption von SOA in einem Unternehmen durch SOA-Aktivitäten anderer Firmen („fad“) sowie von Medien und Beratern („fashion“) beeinflusst wird.

Hinsichtlich der Auswirkung der Einführung von SOA auf Unternehmen belegen die Ergebnisse, dass SOA sowohl die Kosten reduzieren als auch die unternehmerische Agilität, die Datenqualität, das Prozess-Monitoring, die interne Geschäftsprozessintegration (straight-through processing, STP) sowie die unternehmensübergreifende Prozessintegration mit Geschäftspartnern (business-to-business, B2B) verbessern kann. Zusätzlich zeigen die Auswertungen, dass der Nutzen primär durch die Steigerung der Flexibilität der IT im Sinne von Modularität, Integration und Skalierbarkeit erreicht wird. Dabei nimmt allerdings der Grenznutzen mit Zunahme des Reifegrades der SOA-Implementierung ab. Ebenso zeigen die Ergebnisse, dass SOA nicht nur im Zusammenspiel mit Geschäftsprozessmanagement Vorteile für Unternehmen bringt, sondern auch eine gute Basis für das Outsourcing von Geschäftsprozessen (business process outsourcing, BPO) bietet, indem SOA die damit verbundenen Vorteile und die Flexibilität steigert bei gleichzeitiger Reduzierung der Risiken.

Zuletzt liefern die Ergebnisse auch einen Einblick in die Ausgestaltung einer SOA-Governance. Dabei zeigen die Auswertungen unter anderem, dass die Schaffung neuer Entscheidungsstrukturen zu Beginn der Adoption von SOA die Verbesserung der Modularität, Integration und Wiederverwendung erschweren. Daher ist es sinnvoller, zu Beginn der Implementierung die bestehenden Entscheidungsstrukturen weiter zu nutzen anstatt neue zu schaffen. Des Weiteren zeigen die Analysen, dass die Nutzung von Standards, die Qualifikation von Mitarbeitern sowie die Kommunikation zwischen dem IT- und dem Fachbereich wichtig für die Implementierung von SOA sind. Ferner ist die Nutzung von klaren Serviceentwicklungs- und Servicemanagementprozessen sowie die Zusammenarbeit von Fachbereichen wichtig, um die Modularität zu verbessern. Da die Zusammenarbeit zwischen IT- und Fachbereichen nicht allein durch die Adoption von SOA verbessert wird, sollten für eine weitreichende Implementierung von SOA weitere Maßnahmen ergriffen werden, um die Zusammenarbeit zu stärken.

Die Beantwortung der einzelnen Forschungsfragen trägt dabei auf verschiedene Weise zum Stand der Forschung bei: Es werden mehrere theoretische und empirische Erklärungen für die Einflussfaktoren der Adoption von SOA, die Unternehmensvorteile einer Einführung von SOA und die Bedeutung von unterschiedlichen Governance-Mechanismen dargelegt sowie ein multidimensionales SOA-Forschungskonzept und ein Messinstrument für den Reifegrad von SOA entwickelt.

Darüber hinaus trägt die Beantwortung der Forschungsfragen zu einem Thema von hoher praktischer Relevanz bei (Glaser et al. 2007; Merrifield et al. 2008). Laut einer Studie von Forrester Research nutzen mehr als vier von fünf weltweit größten Unternehmen SOA, jedoch haben nur zwölf Prozent von diesen Unternehmen die beabsichtigten Ziele auch tatsächlich erreichen können (Heffner 2010). Somit sind die zusätzlichen Erkenntnisse zu wichtigen Adoptionsfaktoren, den Auswirkungen von SOA auf das Unternehmen und der Bedeutung von Governance-Mechanismen auch für Manager von hohem Interesse, um anhand der Ergebnisse aus der empirischen Erhebung die mit der Einführung von SOA beabsichtigten Ziele besser erreichen zu können.

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INTRODUCTORY PAPER

SERVICE-ORIENTED ARCHITECTURE (SOA): AN EMPIRICAL EVALUATION OF CHARACTERISTICS, ADOPTION DETERMINANTS, GOVERNANCE MECHANISMS, AND BUSINESS IMPACT IN THE GERMAN SERVICE INDUSTRY

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1 Introduction

1.1 Motivation and Objective of the Thesis

Since the first introduction of the term Service-Oriented Architecture (SOA) by Gartner analysts in 1996 (Schulte 1996; Schulte and Natis 1996), the idea of service orientation of IS architectures including SOA and its supporting technologies, such as XML or Web Services, has become a widely adopted concept both in industry and research (Mathiassen and Sorensen 2008; Papazoglou and Heuvel 2007; Papazoglou et al. 2008; Viering et al. 2009)[1]. SOA leverages the principles of object-oriented and component-oriented programming not only for the development of single systems but for entire system landscapes by adding a new service layer consisting of loosely coupled modular services (Siedersleben 2007). To facilitate the communication and integration of these services an enterprise service bus (ESB) is used (Papazoglou and Heuvel 2007; Siedersleben 2007).

In recent years, a number of definitions for SOA appeared that varied with respect to their scope (Erickson and Siau 2008). Researchers applied the concept of service orientation not only for designing business application systems (i.e., a narrow scope of SOA), but also for designing the business architecture and so introduced the concept of a "Service-Oriented Enterprise (SOE)" (Bieberstein et al. 2005b; Brown and Carpenter 2004; Cherbakov et al. 2005; Demirkan and Goul 2006; Janssen and Joha 2008; Vitharana et al. 2007). "The SOE is an enterprise that is modularized in business domains" (Janssen and Joha 2008, p. 35) and directly addresses the claim that "the SOA paradigm also needs to be extended to transmute organizational structures and behavioral practices" (Bieberstein et al. 2005b, p. 691). By becoming an SOE, organizations establish new organizational forms based on shared service centers (Janssen and Joha 2008). In the rest of this work, the term SOA is used to describe the holistic concept covering both the business as well as the IT perspective, following Bieberstein et al. (2005a, p. 5) who define SOA as a "framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities."

Early SOA research focused on technical aspects regarding the characteristics of SOA (Viering et al. 2009). However, while providing a solid technological base for implementing SOA, the business perspective on SOA has been largely neglected and gained increasing attention in recent years (Viering et al. 2009). Thus, papers that investigate SOA through the lens of the business appeared and proposed new research agendas (e.g., Ren and Lyytinen 2008; Vitharana et al. 2007; Zhao et al. 2008). Consequently, authors started to propose conceptual models for investigating specific aspects of SOA from a business perspective, e.g., determinants of SOA adoption (Luthria and

[1] The still growing interest of researchers in this phenomenon is also reflected in the recent publication of various special issues in different journals, e.g., Information Systems and e-Business Management (Volume 9, Issue 2, 2011), Journal of Database Management (Purao et al. 2011), Journal of Management Information Systems (Bardhan et al. 2010), Information Systems Management (Conger 2010), Electronic Markets (Alt et al. 2010), Wirtschaftsinformatik & Management (Pagel 2009), Wirtschaftsinformatik (Abramowicz and Eymann 2008), IBM Systems Journal (Maglio et al. 2008; Seidman and Ritsko 2008), or Information Systems Frontiers (Zhao et al. 2007).

Rabhi 2009), SOA's business impact (Luthria et al. 2007), or developed SOA governance models (Kohnke et al. 2008; Varadan et al. 2008).

Also, first results regarding determinants of SOA adoption, governance mechanisms for implementing SOA effectively or indicating SOA's business impact were shown by case studies (e.g., Baskerville et al. 2005; Ciganek et al. 2009; Eckert et al. 2009; Hirschheim et al. 2010; Oey 2007; Tewary et al. 2009; Trkman et al. 2011; Yoon and Carter 2007), expert interviews (Becker et al. 2011) or by reviewing existing case studies (Mueller et al. 2010). Finally, a few articles applied survey-based research to investigate project success factors (Aier et al. 2011) or specific benefits of SOA, for example, examining SOA's impact on organizational integration (Oh et al. 2007), information sharing in supply chains (Kumar et al. 2007b), or effects on joint venture value (Tafti et al. 2008).

Even though recent research has already increased the understanding of SOA from a business perspective, Viering et al.'s (2009) review of the extant literature identified that there is still a substantial need to extend existing research in the areas of SOA's characteristics, adoption determinants, SOA's business impact, and effective governance mechanisms for SOA. Additionally, my own literature review in **Paper I** shows that researchers struggle to provide theoretical foundations as well as to apply quantitative empirical research to investigate the relationships on a larger empirical basis. The cumulative dissertation thesis at hand addresses these areas by drawing on a multi-theoretical foundation and applying a multi-method approach in order to address the following research directions:

Adoption: Why and under what circumstances do organizations introduce SOA?

Business impact: What are the benefits resulting from SOA?

Governance: How should SOA introduction and management be governed to achieve the benefits?

These research directions are targeted by the eight research articles included in this dissertation thesis and can be connected to the following research questions which guide my research.

The starting point is a literature review to identify the research directions for the remainder of the thesis:

> *RQ1: What are important research directions for investigating SOA from a business perspective? (**Paper I**)*

Next, the characteristics of SOA adoption and SOA maturity need to be assessed for developing measurement instruments for survey-based empirical research that addresses the identified research directions:

> *RQ2a: How can SOA adoption be conceptualized and measured? (**Paper II**)*

> *RQ2b: How can the maturity of an SOA implementation be measured? (**Paper IV**)*

Next, the developed instruments are used to identify different *adoption* patterns and to investigate how they are affected by different SOA adoption determinants:

> *RQ3a: What distinct SOA adoption patterns can be observed? (**Paper II**)*

> *RQ3b: What factors influence SOA adoption? (**Paper II**)*

Next, the outcomes (*business impact*) of adopting SOA are analyzed, again using the developed measurement instruments:

> *RQ4a: What is the business value of SOA? (**Paper III**)*
>
> *RQ4b: What is the business value of SOA maturity? (**Paper IV**)*
>
> *RQ4c: What is the interplay between business process management (BPM) and SOA for achieving business process quality? (**Paper V**)*
>
> *RQ4d: Does SOA facilitate business process outsourcing (BPO)? (**Paper VI**)*

Finally, the importance and role of different SOA *governance* mechanisms is examined by judging them with respect to their impact on SOA's business value (RQ4a):

> *RQ5a: Which SOA governance mechanisms are important for SOA? (**Paper VII**)*
>
> *RQ5b: Does SOA create or require IT/business collaboration? (**Paper VIII**)*

Figure 1 gives an overview of all the research questions in this cumulative dissertation thesis and shows their relationship and interdependence across the entire research context.

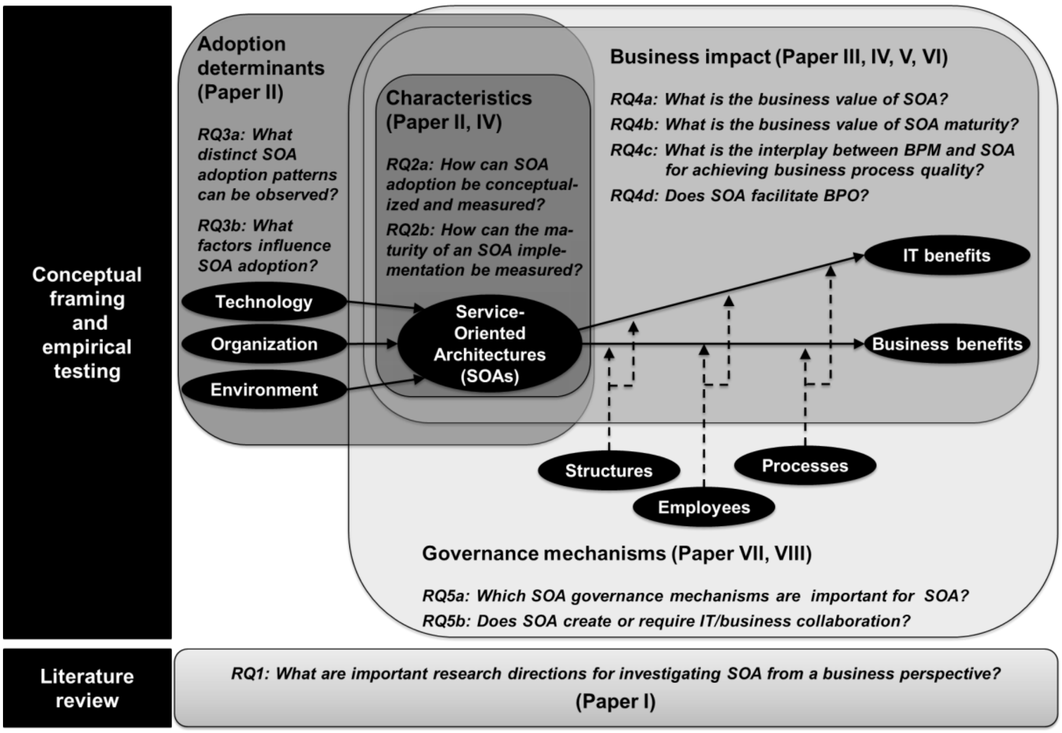

Figure 1. Overview of the research questions in this thesis

Answering these research questions contributes to theory in multiple ways by offering theoretical and empirical explanations for the determinants of SOA adoption, governance mechanisms, and SOA's business impact, as well as providing a newly developed multidimensional SOA research concept and a measurement instrument for SOA maturity.

Moreover, answering these research questions also contributes to a topic of high practical relevance (Glaser et al. 2007; Merrifield et al. 2008). According to Forrester Research, 84% of the global 2,000 enterprises (i.e., organizations with 20,000 or more employees) "say they are using

SOA now or will be by the end of 2010" (Heffner 2010). Despite the high rate of SOA adoption among very large organizations the same study shows that only 12 percent of the global 2,000 enterprises achieve the intended SOA benefits, while 55 percent achieve less or struggle to reap them (Heffner 2010). Thus, insights into questions surrounding important adoption determinants for implementing SOA, SOA's realistic potential business impact, and effective SOA governance mechanisms are of particular importance for managers, especially given that typically there is a high cost associated with introducing SOA (Choi et al. 2010).

1.2 Structure of the Thesis

This cumulative dissertation thesis consists of eight papers. The individual papers use different theoretical foundations and leverage different research methods, i.e., literature review, qualitative case studies, and quantitative methods, consisting of survey-based data collection and subsequent statistical analyses, such as structural equation modeling (SEM) (Chin 1998b), factor analysis, or cluster analysis.

The structure of this thesis can be broken down into three parts. First, the foundation for the thesis is laid by reviewing the literature and identifying research questions (**Paper I**). Second, necessary prerequisites for applying quantitative methods are developed in terms of conceptualizing SOA adoption and developing measurement instruments for SOA adoption and SOA maturity based on their characteristics (**Paper II** and **Paper IV**). Third, the empirical results answering the research questions are presented regarding SOA's adoption patterns and determinants (**Paper II**), the business impact of adopting SOA (**Paper III** to **Paper VI**), and governance mechanisms for achieving SOA's benefits (**Paper VII** and **Paper VIII**). By testing the developed research models statistically to answer the proposed research questions, this thesis follows a positivist research perspective, reflecting the fact that "IS research can be classified as positivist if there is evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from a representative sample to a stated population" (Klein and Myers 1999, p. 69).

Figure 2 visualizes the structure of the overall thesis and how the papers are related to and draw on each other. Each paper is summarized in further detail in section 4.

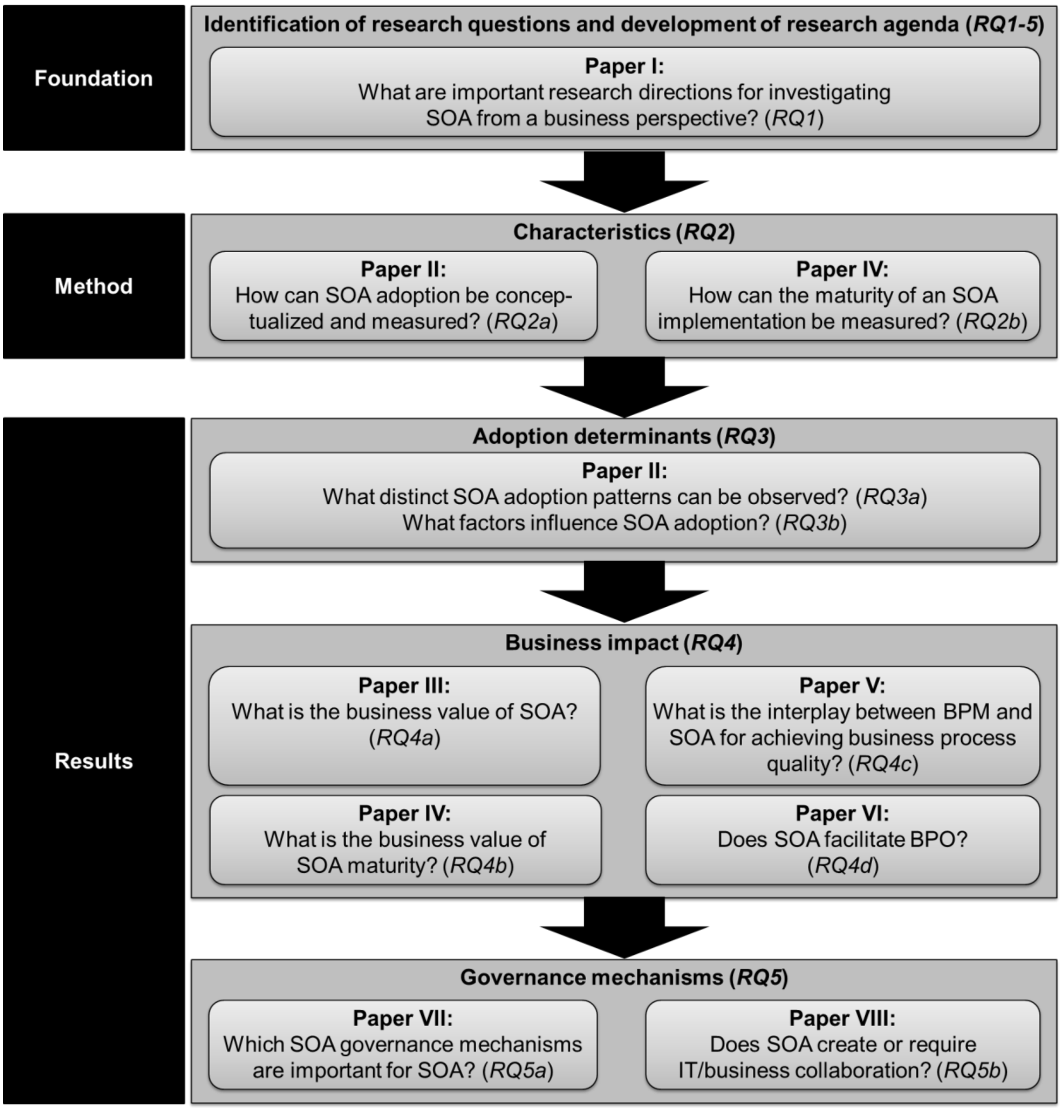

Figure 2. Structure of the thesis

In the next chapter of this introductory paper, the most important theoretical foundations and related research are presented. Section 3 gives an overview of the methodologies applied in this thesis and the data used to evaluate the research questions addressed in the various papers. In section 4, the main results of each paper of this cumulative dissertation thesis are summarized. Lastly, section 5 highlights the contributions to theory as well as managerial implications, followed by a discussion of the limitations (section 6) and opportunities for future research (section 7).

2 Theoretical Foundation and Related Research

As the individual papers draw on different related research and theoretical foundations, only the most important are presented in this section: SOA, modular systems theory, IT flexibility, dynamic capabilities theory, and the technology-organization-environment framework. Further specific related research on SOA maturity models, BPM, business process quality, SOA governance, BPO, IT/business collaboration, and shared mental models, used in the papers are introduced briefly in section 4 when the main results are presented.

2.1 Service-Oriented Architecture

SOA draws on the principles of object-oriented and component-oriented programming and applies them not only to the development of single systems but to the development of entire system landscapes (Siedersleben 2007). The IT layer and the business processes layer are separated by adding a new service layer which comprises loosely coupled modular services (Siedersleben 2007). According to Siedersleben (2007), SOA mainly draws on three principles: component orientation with clearly defined interfaces, loose coupling of services, and controlling the workflow with a separate component. An ESB is used to adhere to the principles as well as to facilitate the integration of the services (Papazoglou and Heuvel 2007; Siedersleben 2007). Although, service implementations based on Web Services standards, such as SOAP and Web Services Description Language (WSDL), “are the most popular type of services available today” (Papazoglou and Heuvel 2007, p. 390) the SOA concept is not bound to any technology but only to an architectural paradigm.

Even though the basic principles introduced above are found to be quite consistent throughout the literature, there are still numerous definitions of SOA in use that vary with respect to their scope (Erickson and Siau 2008). Some are limited to the IT layer, some focus on the business layer, and others holistically include both the IT and the business layer:

- Krafzig et al. (2005, p. 57) present one example of a definition limiting SOA to the IT layer: “a Service-Oriented Architecture (SOA) is a software architecture that is based on the key concepts of an application frontend, service, service repository, and service bus.”
- By contrast, Lublinsky (2007) adopts a business perspective: “SOA can be defined as an architectural style promoting the concept of business-aligned enterprise service as the fundamental unit of designing, building, and composing enterprise business solutions.” This business-oriented view of service orientation was advanced by Janssen and Joha (2008, p. 35) to define a Service-Oriented Enterprise (SOE): “The SOE is an enterprise that is modularized in business domains.” Organizations seeking to become an SOE will establish shared service centers for creating ”new products […] by orchestrating the services provided by the service centers” (2008, p. 35).
- Bieberstein et al. (2005a, p. 5) define SOA as a holistic concept covering both the business as well as the IT perspective: SOA is a ”framework for integrating business pro-

> cesses and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities."

Overall, the definitions reveal similarities but also differences with respect to the scope of SOA. In the last few years, researchers applied the concept of service orientation not only for designing business application systems (i.e., a narrow scope of SOA), but also to design the business architecture, i.e., the concept of an Service-Oriented Enterprise (SOE) (Bieberstein et al. 2005b; Brown and Carpenter 2004; Cherbakov et al. 2005; Demirkan and Goul 2006; Janssen and Joha 2008; Vitharana et al. 2007). This addresses the claim that besides the technical perspective "the SOA paradigm also needs to be extended to transmute organizational structures and behavioral practices" (Bieberstein et al. 2005b, p. 691). SOE "as an emerging architecture-of-business takes the view that service orientation helps to execute the business strategy of an enterprise with significant multi-dimensional benefits (flexibility to change, enhanced quality, effectiveness), in less time (time-to-value) and cost (efficiency) using IT" (Vitharana et al. 2007, p. 3). Applying service orientation to the business layer as well (i.e., SOE) leads to new organizational forms using shared service centers (Janssen and Joha 2008). Approaches for implementing shared services centers can benefit from the existing body of research on approaches for identifying and designing services as well as entire SOAs (e.g., Arsanjani et al. 2008; Bernhard and Jahn 2009; Krammer et al. 2011; Thomas and Weistroffer 2007; Thomas et al. 2009; vom Brocke et al. 2009b; Winkler and Buhl 2007).

Reviewing that part of SOA-related research which applies quantitative empirical research methods shows that SOA has only rarely been considered in such studies and has only been rudimentarily conceptualized and operationalized; existing concepts and measures for investigating the extent of SOA in an organization are not available. For example, Kumar et al.'s (2007b) conceptualization of SOA focuses on the binary assessment of using some of the technologies commonly applied for implementing SOA (XML and Web Services), whereas Tafti et al. (2008, p. 13) consider "the number of business functions for which SOA is used" as well as "the deployment of services-based architecture" in addition to XML and Web Services to measure SOA with four single items. By contrast, Oh et al. (2007) account for general architectural design principles and again some typical technologies (i.e., XML, WSDL, SOAP, and UDDI). Thus, for useful empirical SOA research as well as for answering the research questions, a more comprehensive and unifying SOA research construct is needed to capture SOA in a holistic way.

As this thesis follows Bieberstein et al.'s (2005a) holistic understanding of SOA covering both the business and technical layers, the different definitions are integrated by assessing the degree of service orientation of the enterprise architecture. This allows for a comparison of the degree of service orientation along the classical layers of enterprise architecture (EA) frameworks or models as published by various authors and institutions[2], in order to gain a more complete picture of the SOA initiatives of organizations without discarding particular scopes proposed for SOA. Meschke and Baumoel (2010) show that Winter and Fischer's EA representation (2007) consisting of five layers can be consolidated to three layers: process, application, and system architectures. Using only three layers to describe an EA is consistent with the widely used EA framework TOGAF 9 (The Open Group Architecture Framework) (The Open Group 2009b), which distinguishes business, IS, and technology architectures. The three common layers used in the presented enterprise

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[2] Overviews about further EA representations can be found in Aier et al. (2008) and Meschke and Baumoel (2010).

architecture frameworks can also be found in the more comprehensive EA model developed by Ferstl and Sinz (1995; 1998). This model includes, in addition to these three layers, an outside view of the business system (i.e., the enterprise plan) as well as the specification of further resources besides business application systems (i.e., personnel, machines and plants). Table 1 compares how these EA frameworks map on to each other:

TOGAF 9 (The Open Group 2009b)	Ferstl and Sinz (1995; 1998)	Meschke and Baumoel (2010)	Brown and Karamouzis (2001)	Winter and Fischer (2007)
	enterprise plan			
business architecture	business process model	process architecture	business process	business architecture
				process architecture
IS architecture (data and application architecture)	specification of resources (personnel, business application systems, machines and plants)	application architecture	business applications	integration architecture
				software architecture
technology architecture		system architecture	infrastructure	technology architecture

Table 1. Comparison of enterprise architecture frameworks

Previous research investigates service orientation at each of the architecture layers as proposed by TOGAF 9. At the business architecture level, the use of component business models (Ernest and Nisavic 2007) or the implementation of shared service centers (Janssen and Joha 2008) are recommended for SOA. At the IS architecture level, different design principles are proposed for SOA, e.g., loose coupling, composability, or division of reusable logic (Erl 2005). Lastly, at the technology architecture level, different technologies available for implementing SOA are suggested, e.g., Web Services, ESB, service registry/repository, or business process execution language (BPEL) (Kumar et al. 2007b; Oh et al. 2007).

By integrating the various definitions and conceptualizations found in the literature, a multidimensional SOA research concept is developed in section 4.2.

2.2 Modular Systems Theory

Modularity has been investigated in manifold fields, such as IS (role of IT modularity), Production Research (role of product modularity), or Organization Science (role of organizational modularity) (Schilling 2000). The oldest strand of modularity research in the business field emerged in the product design domain. Modularity of physical products has important implications for R&D effectiveness (Takeishi 2002), production efficiency (Baldwin and Clark 2000), sourcing strategies (Schilling 2000), and the organizational structure of the manufacturer, because the modularity of the manufacturer's organization needs to be aligned with the modularity of the products manufactured (Hoetker 2006; Langlois 2002). The organizational modularity enables the firm to outsource parts of the product development and has led to a blurring of firm boundaries and to strong increases in interorganizational relationships and alliances (Anand and Daft 2007; Duncan 1979).

While modularity is a key theme in many scientific disciplines a thorough theoretical and empirical consideration of modularity as a key constituent in services metaphors in general and for SOA in particular is scarce. Thus, in this thesis SOA is seen from the perspective of the modular systems theory. Schilling (2000, p. 312) defines modularity as follows: "Modularity is a general systems concept: it is a continuum describing the degree to which a system's components can be separated and recombined, and it refers both to the tightness of the coupling between components and the degree to which the 'rules' of the system architecture enable (or prohibit) the mixing and matching of components." Essentially, almost all biological, technical and other systems can be interpreted as hierarchically nested modular systems (Simon 1962) that "are intentionally designed to require low levels of coordination so that they can be carried out by an organizational structure of quasi-independent divisions functioning as loosely coupled subsystems" (Sanchez and Mahoney 1996, p. 64). "The crux of modular systems theory is that greater modularity facilitates rapid changes in individual subsystems by lowering the need for coordinated changes in others" (Tiwana and Konsynski 2010, p. 290). In turn, a decrease of coordination needs and efforts leads to higher flexibility and real options (Tiwana 2008) for adapting the system to an emerging need.

The existing literature mainly investigated the impact of modularizing products on manufacturing outsourcing rather than the impact of modularizing (immaterial) business processes on outsourcing services. By moving the focus from products to business processes one can argue that product modularization and business process modularization are comparable concepts. A business process consists of logically related tasks (Davenport 2005), which match with the components of a product. Also, a business process can be broken down into sub-processes (Basu and Blanning 2003). Thus, modularizing products into modules is comparable to modularizing processes into sub-processes with respect to sourcing decisions.

As business processes are typically supported by IS in today's organizations, one way of modularizing these IT-reliant business processes is by using SOA. The single services of an SOA encapsulate parts of business processes (i.e., business functions) in order to minimize interdependencies between different modules (Mithas and Whitaker 2007). In this vein, business processes and supporting applications can be modularized into services by adopting SOA (Papazoglou and Heuvel 2007). As is the case for each modular system, the components or services of an SOA represent other subsystems that can, again, be viewed as a modular system consisting of finer, loose services (Simon 1962). However, "loose does not mean lax; loosely coupled systems operate to very stringent performance requirements" (Hagel and Brown 2005, p. 85). For example, a modular, loosely coupled product design enables a decentralized production process in cases where well-defined standard interfaces exist. This allows employees to work on separate components while still ensuring that the resulting components can interact effectively (Schilling 2000). In the context of SOA, dedicated governance and management mechanisms define the necessary standards for locally developed modularized services to interact and facilitate the reuse of services in different processes.

2.3 IT Flexibility

One aim of introducing SOA, mentioned consistently in the literature, is to increase IT flexibility (Mueller et al. 2010; Yoon and Carter 2007). Duncan defines IT infrastructure flexibility[3] as "the ability of the IS department to respond quickly and cost-effectively to systems demands, which evolve with changes in business practices or strategies" (1995, p. 44). Drawing on this definition, Byrd and Turner (2000) distinguish between the flexibility of the IT employees and the flexibility of the technical IT infrastructure (referred to as IT flexibility). The focus of this thesis is limited to the latter since this is the layer where SOA plays its main role; nevertheless, it is noteworthy that

[3] The expressions "IT flexibility" and "IT infrastructure flexibility" are used synonymously in the remainder of this thesis.

SOA might facilitate a knowledge exchange that is likely also to affect capabilities, and thus the flexibility of IT employees.

According to Duncan (1995), technical IT infrastructure flexibility depends mainly on the degree to which IT resources are reusable and commonly accessible. Based on these two aspects, Duncan defines three criteria for flexibility: (1) *connectivity*, which allows the connection of different components; (2) *compatibility*, which facilitates interaction and information exchange between connected components; and (3) *modularity*, which aims at "isolating and standardizing as many business and systems processes as possible" (1995, p. 48). However, Byrd and Turner (2000) showed empirically that a separation of *connectivity* and *compatibility* does not hold. Thus, they suggest a new concept of *integration* that embraces both. Further, Byrd and Turner confirmed modularity as the second criterion, but give another definition for it: "the ability to add, modify, and remove any software, hardware, or data components of the infrastructure with ease and with no major overall effect" (2000, p. 171).

Chanopas et al. (2006) suggest extending the concept of technical IT infrastructure flexibility and propose five additional characteristics[4]: scalability (11), modernity (6), continuity (2), rapidity (2), and facility (1). Besides the characteristics already defined by Byrd and Turner (2000), *scalability* is the only one of the five newly identified characteristics, which is consistently reported by all 11 IT experts in Chanopas et al. (2006). The other characteristics are only reported by some of the IT experts and can thus be considered to be of less importance. Scalability has been defined as "the degree to which hardware/software can be scaled and upgraded on existing infrastructure" (p. 645) and is of particular importance regarding the effect of service orientation. Solutions based on SOA are generally expected to exhibit a higher scalability than point-to-point connections since an ESB is applied for application integration. One problem with point-to-point connections is the rapid slope of handling complexity with an increasing number of systems to be integrated (Papazoglou and Heuvel 2007).

According to the previous research described above, integration, modularity, and scalability represent the sub-dimensions of IT flexibility used in this thesis.

2.4 Dynamic Capabilities Theory

The dynamic capabilities theory (DCT), which is built on the resource-based view (RBV), establishes the theoretical foundation for analyzing SOA's business impact. The RBV defines the characteristics resources must possess to deliver a sustained competitive advantage (Barney 1991; Penrose 1959): "sources of sustained competitive advantage are firm resources that are valuable, rare, imperfectly imitable, and non-substitutable" (1991, p. 101). Correspondingly, IT – comprising technical, personal and organizational components – can lead to a sustained competitive advantage and thus can be classified as a resource (Bharadwaj 2000; Melville et al. 2004).

One of the main criticisms of the RBV is that it only offers a rather static view on selecting the resources, rather than providing insights into how an organization can develop and integrate such resources to achieve a competitive advantage (Mahoney and Pandian 1992; Makadok 2001). The DCT addresses this shortcoming and defines "dynamic capabilities as the firm's ability to inte-

[4] The number of IT experts out of a total of 11 interviewees reporting the respective characteristic of IT infrastructure flexibility is given in parentheses.

grate, build, and reconfigure internal and external competencies to address rapidly-changing environments" (Teece et al. 1997, p. 516). Accordingly, an organization's competence to deal with its changing environment results from a dynamic capability. Consequently, Makadok (2001, p. 389) distinguishes "resource-picking and capability-building mechanisms". Resource-picking describes the ability of an organization to select superior resources and avoid implementing resources that are below average. Capability-building refers to the skill of an organization to deploy resources to enhance the outcomes of the resources.

By combining the perspectives of developing competencies with picking the right resources (Makadok 2001) and applying them to the research domain of this thesis, SOA can be classified as a resource while, for example, IT flexibility is a resulting capability. SOA is seen as one of multiple alternatives from which an organization can choose in order to improve an organization's competitiveness; picking SOA results from a managerial decision that sees SOA as the most promising possibility. IT flexibility is seen as a complementary capability improving SOA's benefits. Thus, DCT provides a theoretical lens for investigating SOA's business impact and specifically the role of IT flexibility. In this way, an implemented SOA is treated as a resource that an organization uses for its purposes. To achieve more of the SOA's potential benefits an organization needs to exhibit a dynamic capability (e.g., IT flexibility) that improves SOA as a resource. Thus, leveraging both SOA as resource and IT flexibility as a dynamic capability will lead to strategic/sustainable business value.

2.5 Technology-Organization-Environment (TOE) Framework

The dominant paradigm in IT adoption research explains innovation by investigating the impact of innovation-related abilities or needs on the earliness, frequency, or extent of adoption (Fichman 2004). Thereby, it distinguishes between the adoption of innovations by individuals, organizational units, organizations, or groups of inter-related organizations (Fichman 2004). For research at the individual level of adoption many different theories have been applied, developed, and tested, e.g., theory of reasoned action (Fishbein and Ajzen 1975), diffusion of innovations theory (Rogers 2003), technology acceptance model (TAM) (Davis 1989), or unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al. 2003).

According to Fichman (1992), the research at hand addresses the *organizational* level of adoption because no a single individual decides to adopt and use a certain technology by herself, but an organization decides to rebuild its architectures. This makes modifications and extensions to traditional adoption models necessary. A common framework used for conceptualizing adoption models at the organizational level is the technology-organization-environment (TOE) framework (DePietro et al. 1990) which has been developed for investigating the adoption of innovations by organizations in contrast to individuals. According to Jeyaraj et al.'s (2006) findings from analyzing 51 studies, the dominant research paradigm for organizational adoption studies is based on three dimensions: innovation (i.e., the artifact to be adopted), organizational, and environmental characteristics. Hence, the TOE framework from DePietro et al. (1990) is often applied; it incorporates both internal and external determinants that influence the adoption of a (technological) innovation (such as SOA in this case). The TOE framework covers the three dimensions identified by Jeyaraj et al. (2006) and has been applied successfully in different studies, such as those on the adoption of inter-organizational systems (e.g., Chau and Tam 1997; Mishra et al. 2007; Zhu and Kraemer 2005), and supports the analysis of what leads a *potential* adopter to become a *genuine* adopter of SOA.

The TOE framework describes three (groups of) determinants that may influence the adoption of a technological innovation (DePietro et al. 1990, p. 153+154):

- *Technological context* describes "the internal and external technologies relevant to the firm", which includes the availability of the technologies as well as their characteristics, such as their benefits or costs.
- *Organizational context* captures all relevant properties of the organization that makes the adoption decision, such as firm size, managerial structure, human resources, or slack resources available.
- *Environmental context* is "the arena in which a firm conducts its business", covering its industry and competitors, markets, access to external resources, and relationships with institutions.

While the TOE framework defines these three contexts, it offers no details regarding which factors are important within each context. Additionally, Wolfe states that a large number of determinants of organizational innovation emerged (1994). Comparing Wolfe's finding with Jeyaraj et al.'s review (2006), which lists a wide range of 100 different variables to predict organizational adoption, one can see that nothing has changed over recent years.

Hence, during my thesis research, I conducted a detailed literature review of how studies applying the TOE framework fill these three context "containers" (see Online Appendix of Paper II for details) and analyzed 38 empirical quantitative studies regarding the organizational adoption of technologies based on the three contexts. From this analysis the concrete adoption determinants for investigating SOA adoption, which also integrate the evaluation of SOA's benefits, were derived.

3 Methodology

The procedure of this dissertation follows Gable (1994), who suggests starting with a literature review, then conducting case studies, and finally applying survey methods. This multi-method research approach combines the strength of each method (case studies: discoverability and handling more complex models; survey: external validity/generalizability of results) by leveraging an exploratory approach to increase the understanding for the subsequent positivist research perspective (Gable 1994). Figure 3 illustrates the research approach applied in this dissertation.

The dissertation began with the definition of the broad research context in Phase I. Next, a literature review was conducted to define the concrete research problem and to identify research questions of particular interest for research on SOA from a business perspective (**Paper II**). Based on these results an initial conceptual framing of the research models necessary to answer the proposed research questions was carried out and the research design for Phase II and III was defined.

In the second phase, nine case studies were conducted to understand SOA adoption, its implications for the organization as well as the used governance mechanisms in depth, and to refine the research models based on further insights from practice. New findings arising from the case studies informed a second round of literature analysis, which led to a refinement of the research models guiding the third phase.

The third and last phase used the results of the previous phases and empirically tested the developed conceptual models using the data of 247 participating organizations collected through a survey carried out in the German service industry. **Paper II** to **Paper VIII** interpret and discuss the findings based not only on the analysis of the quantitative data, but also having revisited the literature and leveraged the insights from the case studies.

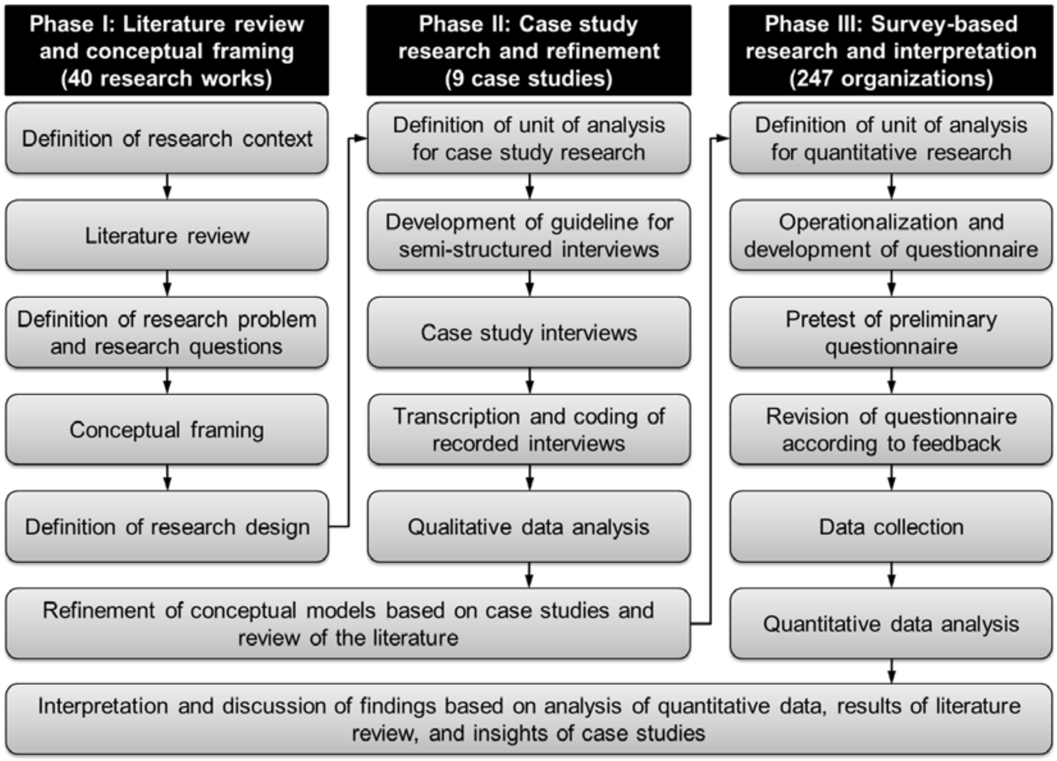

Figure 3. Overview of multi-method research approach used in this thesis

The following subsections explain in more detail the methodologies used (literature review, qualitative research, and quantitative research).

3.1 Literature Review

The literature review presented in **Paper I** is carried out in accordance with general guidelines for literature reviews (Webster and Watson 2002) and follows a structured literature review approach, as, for example, described in vom Brocke et al. (2009a). The framework is structured into five phases, which are summarized as follows: (1) definition of review scope, (2) conceptualization of topic, (3) literature search, (4) literature analysis and synthesis, (5) research agenda.

(1) The *definition of the review scope* of the literature review is summarized in Figure 4 (categories applicable to this review are highlighted), which is based on the taxonomy proposed by Cooper (1988) and adapted by vom Brocke et al. (2009a).

Characteristics	Categories			
Focus	**research outcomes**	research methods	theories	**applications**
Goal	**integration**	criticism		central issues
Organization	historical	**conceptual**		methodological
Perspective	**neutral representation**		espousal of position	
Audience	**specialized scholars**	general scholars	practitioners/politicians	general public
Coverage	exhaustive	exhaustive and selective	**representative**	central/pivotal

Figure 4. Taxonomy of the literature review on SOA (based on Cooper 1988; and vom Brocke et al. 2009a); highlighting represents chosen alternatives for SOA literature review

The literature review in Paper I *focuses* on research outcomes of research applied in the domain of SOA. The *goal* is to integrate findings with respect to four areas of SOA research and is thereby *organized* along a conceptual structure, i.e., characteristics, adoption determinants, governance mechanisms, and business impact. No particular *perspective* is taken, in order to guarantee a neutral representation of the review results. The *audience* addressed by this review are specialized scholars interested in SOA or SOE. According to the taxonomy of literature reviews, the *coverage* can be classified as representative, as it is limited to a sample of articles which also stand for other articles, but does not explicitly consider the entirety of the literature.

The second step is (2) *conceptualization of the topic* which addresses the point that "the author of a review article must begin with a topic in need of review and a broad conception of what is known about the topic and potential areas where new knowledge may be needed" (Torraco 2005, p. 359). The review draws on the framework for analyzing SOA research, developed by Viering et al. (2009), and classifies SOA research with respect to the following areas: characteristics, adoption determinants, governance mechanisms, and business impact.

(3) The sources for the *literature search* are selected based on the top 25 research journals according to the ranking presented by Lowry et al. (2004). In addition, the IBM Systems Journal which is listed as top global practitioner journal (Lowry et al. 2004) covering a significant part of SOA research was included. Also, four IS conferences (Americas Conference on IS (AMCIS), European Conference on IS (ECIS), Hawaii International Conference on System Sciences (HICSS), and International Conference on IS (ICIS)) are considered to cover more recent SOA research. Finally, also three widely-cited SOA books (Erl 2005; Keen et al. 2004; Krafzig et al. 2005) are considered to give a more complete picture. The selection approach, as well as the combination of the different types of research works (journal articles, conference papers, and books), are a means to support a representative coverage of the literature.

The next step (4) *literature analysis and synthesis* consists of the actual analysis of the identified literature with respect to the characteristics of the literature review (cf. step 1) and the conceptualization of the topic (cf. step 2). More details on how the papers were evaluated regarding their fitting to the review context and how their findings were synthesized to assemble the review findings are described in Paper I.

The focus of the last step (5) *research agenda* is the development of a research agenda for future research that identifies research questions based on the previous step (4), and thereby builds the foundation for the remaining paper of this thesis.

3.2 Qualitative Research

Due to the relatively immature body of literature regarding SOA from a business perspective, a qualitative research approach was chosen for Phase II to increase the understanding regarding the research context before designing the survey. An exploratory multi-case study approach was followed to gain further insights from practice complementing the literature (Dubé and Paré 2003; Stake 2006; Yin 2003). The objective of the case studies is to identify how SOA is implemented in organizations, which adoption determinants are important for adopting SOA, what business impact SOA has, and which governance mechanisms have been applied. Applying this qualitative approach prior to the quantitative research has the advantage of gathering descriptive and exploratory data to support theory development and the subsequent theory testing using survey-based research (Lee 1989, p. 46).

In total, nine organizations operating in the German service industry were chosen as the unit of analysis and eleven interviews with different persons from IT architects to CIOs were conducted. The participants were identified using a purposeful intensity sampling approach that aims at selecting those participants that are expected to present information-rich cases with significant SOA projects offering broad insights into the phenomenon (Patton 2002). Following qualitative research recommendations (Eisenhardt 1989; Yin 2003) the interviews were conducted following a semi-structured interview guideline consisting of open-ended questions to ensure that all research directions were investigated. According to Eisenhardt's suggestion (1989), all interviews were conducted on-site with two researchers taking protocols. All interviews were conducted in German and with the exception of two interviews all were also recorded. Each interview lasted about 1.5 to 3 hours and was transcribed afterwards. The transcripts of the nine recorded interviews comprise about 126,000 words. In addition to the interviews, complementary sources of evidence, e.g., presentations and documentations provided by the organizations or external descriptions of the organizations or the projects, were used to gain further insights in the cases and to increase the validity of the case study analysis (Yin 2003).

To analyze the data MAXQDA was used, which is a special software designed for supporting qualitative data analysis. It allows the importing of transcripts, supports coding of the content, or further structuring of the information using memos, and offers multiple ways of retrieving information of single cases, across cases or to compare different cases.

Based on the new findings in the case studies, the literature was reviewed again and the conceptual models were refined to incorporate the new findings for the third phase (i.e., the quantitative research approach). However, this cumulative dissertation thesis does not include a paper using only a qualitative research method; instead the insights from the case studies are used to interpret the findings from the quantitative analyses in several of the papers.

3.3 Quantitative Research

Paper II to **Paper VIII** use a quantitative research approach to answer the different research questions by evaluating different research models using empirical data collected in a survey. The survey was conducted in the German service industry, covering several sub-industries such as logistics, trade, financial services, media & telecommunication and others (i.e., US SIC codes 4,000 to 8,999). We chose the service industry because of the relatively important role of IT compared to other resources, such as production facilities, raw materials, and so on. In the service industry, IT is, besides HR, often the only “production factor”; this allows for controlling industry characteristics that otherwise might covariate our results.

We contacted the 3,000 largest organizations (according to number of employees) in the German service industry by phone to identify the leading IT architect and request participation in the survey. The data were collected by mailing a paper-based questionnaire and using reminders (via mail and phone). To avoid sending a too lengthy questionnaire, two different versions of questionnaires were used that both had similar questions identical in both questionnaires as well as unique questions only asked in one version. The questionnaire with the main focus on adoption determinants and business impact was sent to 955 identified contacts and received from 174 organizations (i.e., a response rate of 18.2%). The second questionnaire with the main focus on IT/business collaboration and BPO was sent to 1,023 identified contacts and received from 158 organizations (i.e., a response rate of 15.4%). Overall a completed questionnaire could be received from 247 organizations. To each organization that answered one version of the questionnaire and had not chosen to stay anonymous, the unique questions belonging to the other version of the questionnaire were sent. Thus, 85 organizations answered both versions of the questionnaire, while 162 organizations answered only one of the two questionnaires.

Figure 5 provides descriptive statistics on the responding firms with respect to firm size and industry sector. The distribution of sectors among the 247 participating organizations was considered representative for the 3,000 largest organizations (according to number of employees) operating in the German service industry.

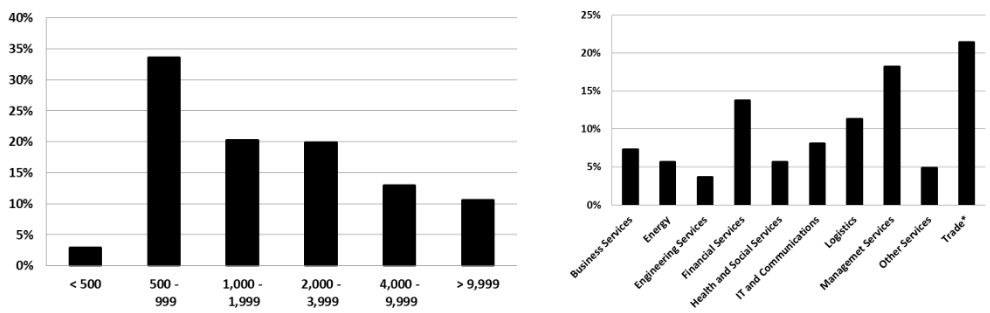

Figure 5. Left: Distribution of firm sizes based on number of employees; right: Distribution of sectors within the service industry (* some trade firms also produce the traded goods)

Figure 6 shows the responses of the 247 participants to the question, when did they begin using SOA in their organization. With 45 percent stating that they use SOA the results are comparable to the results of a Gartner survey conducted in July 2009 among organizations in United States, Western Europe, Australia, Singapore, and India (Tan 2009). According to the Gartner survey, 48 percent of organizations with 500 or more employees have been using SOA (Tan 2009). Thus, despite the fact that the Gartner survey was conducted in a larger geographic area the data was collected at approximately the same time at organizations of the same size, which indicates that the survey results are also representative with respect to the SOA usage of the organizations.

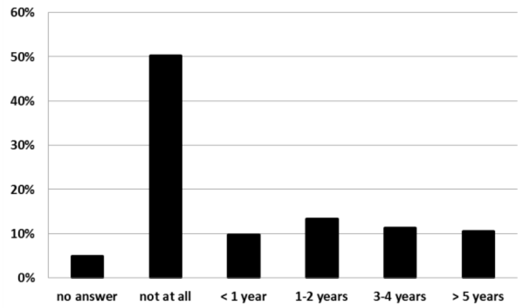

Figure 6. "How long has your organization used SOA?"

The following subsections explain the main quantitative approaches that are used in this thesis: Structural Equation Modeling (SEM), factor analysis, and cluster analysis.

3.3.1 Structural Equation Modeling

SEM techniques, which are seen as second generation of multivariate analysis, offer researchers "the ability to perform path-analytic modeling with latent variables" to test a set of hypotheses empirically (Chin and Newsted 1999, p. 307). These SEM-based procedures outperform first generation techniques of multivariate analysis, e.g., discriminant analysis, multiple regression, or analysis of variance or covariance, as they "involve generalizations and extensions of first-generation procedures" (Chin and Newsted 1999, p. 308). The claim that SEM is better for testing path diagrams empirically is also backed up recently in *MIS Quarterly*: "There are unique advantages to SEM over linear regression in that SEM allows the creation and estimation of models with multiple dependent variables and their interconnections at the same time" (Gefen et al. 2011, p. iv) "that make SEM *a priori* the methods of choice in analyzing path diagrams when these involve latent variables with multiple indicators" (Gefen et al. 2011, p. iv).

A latent variable (also referred to as construct or in-/ dependent variable) is a theoretical construct that cannot be measured directly. Instead the unobservable latent variable is measured using a measurement instrument consisting of indicators or observed/ manifest variables that correspond to specific items (questions or statements) of a questionnaire. One example of a latent variable is *close IT/business collaboration* used in **Paper VIII** that investigates how closely and well business and IT work together at non-strategic levels. This latent variable cannot be measured directly, but can be represented by a measurement instrument consisting of multiple questionnaire items that are, for example, rated on a 5-Likert scale from "fully disagree" to "fully agree".

Measurement instruments can either be specified as reflective or as formative measurement models (Bagozzi 2011; Bollen 2011). In a reflective measurement model the indicators are formulated in such a way that they reflect the latent variable; if the value of the construct changes, all indicators are supposed to change accordingly. In a formative measurement model, the indicators form the construct; if one of the indicators changes, the latent variable is supposed to change accordingly. Statistically the indicators belonging to a reflective measurement model should correlate highly with each other while the indicators of a formative measurement model should not correlate highly to avoid multi-collinearity issues. In this thesis, the majority of constructs were operationalized by reflective multi-item measures while the minority uses formative measurement models. Last, besides first-order constructs that consist of only one latent variable with a corresponding measurement model, also second-order constructs that consist of two or more first-order constructs are commonly used. These higher order latent variables are used when a theoretical construct has different subdimensions that each should be measured with its own measurement model (Chin 1998a; Polites et al. 2012).

A SEM model consists of two parts: the measurement model and the structural model. The measurement (or outer) model comprises the relationships of the latent variables with their indicators. The structural (or inner) model represents the hypothesized causal paths to be tested and comprises the relationships between the latent variables. As SEM integrates both models (i.e., measurement and structural model) into a simultaneous assessment and is able to "analyze many stages of independent and dependent variables […] into one unified model" (Gefen et al. 2011, p. iv) it "allows a better estimation of both measurement and structural relationships" (Gefen et al. 2011, p. iv).

In IS research, Partial Least Squares (PLS) and Covariance-Based Structural Equation Modeling (CBSEM) are "the two most widely used types of SEM" (Gefen et al. 2011, p. v). Prominent software based on CBSEM are LISREL and AMOS; the PLS approach is, for example, implemented in SmartPLS and PLS-Graph. Despite other differences, both types most notably differ with respect to their approach (PLS is variance based while CBSEM is covariance based) and their objective (PLS is prediction oriented while CBSEM is parameter oriented), which makes PLS the primary method for exploratory research and CBSEM for confirmatory research (Chin and Newsted 1999; Gefen et al. 2011). Thus, PLS is better suited to research where the phenomenon (i.e., SOA from a business perspective) investigated is relatively new and the theoretical models and measures are not well formed in prior research (Chin and Newsted 1999; Gefen et al. 2011).

In this thesis, existing ready-to-use measurement instruments were used from the literature where possible. As theoretical models and measures where largely missing the investigation of SOA, new measurement models had to be developed based on the literature and the case studies. A first version of the questionnaire was discussed with a group of researchers experienced in the field of SOA. Then, an industry panel consisting of consultants active in the SOA domain was asked to assess the items and their content. The questionnaire was then revised based on the feedback to avoid, for example, unclear, too lengthy, or ambiguous formulations. As all models, and also to a large extent the measures, were newly developed as part of this thesis, PLS instead of CBSEM was chosen because its suitability for exploratory research fits with the research conducted in this thesis. Additionally, PLS is more suitable for formative measurement models while those frequently create statistical identification problems in CBSEM (Gefen et al. 2011).

3.3.1.1 Accounting for Possible Impact of Biases

Besides the common evaluation of the measurement models regarding their reliability and validity, the data is also analyzed regarding *non-response bias* that deals with the criticism that "persons who respond differ substantially from those who do not" (Armstrong and Overton 1977, p. 396). Armstrong and Overton (1977) assume that the respondents answering only after a reminder share some similarities with those who did not respond at all. Thus, the answers given by organizations that reacted without a reminder were compared with those answers of organizations that answered only after a reminder. If this comparison did not show significant differences one can assume that the data is not prone to *non-response bias* (Armstrong and Overton 1977).

Another bias to examine is *common method bias* (CMB). If the data is impacted by CMB the observed variance is largely attributable to the chosen method rather than to the intended latent variables that the measures should represent (Podsakoff et al. 2003). To control a priori for CMB in terms of context and item ordering bias, we used different scale formats for the various constructs and distributed two versions of the questionnaire with altering item sequences. Further, we applied different tests ex post to assess whether and to what extent our data might be impacted by CMB: the Harman single factor test (Podsakoff et al. 2003), using a theoretically unrelated marker variable as proxy for a common method factor (Lindell and Whitney 2001; Podsakoff et al. 2003), or an unmeasured latent method factor as suggested by Liang et al. (2007) to test for the impact of CMB on the test results of our models.

3.3.1.2 Mediation and Moderation Analysis

An independent latent variable *A* can affect a dependent variable *B* directly or indirectly. In the first case one would find a direct hypothesized path from *A* to *B*. In the latter case one could either have a mediating effect or a moderating effect of a latent variable *C* that is called mediator or moderator respectively (Figure 7).

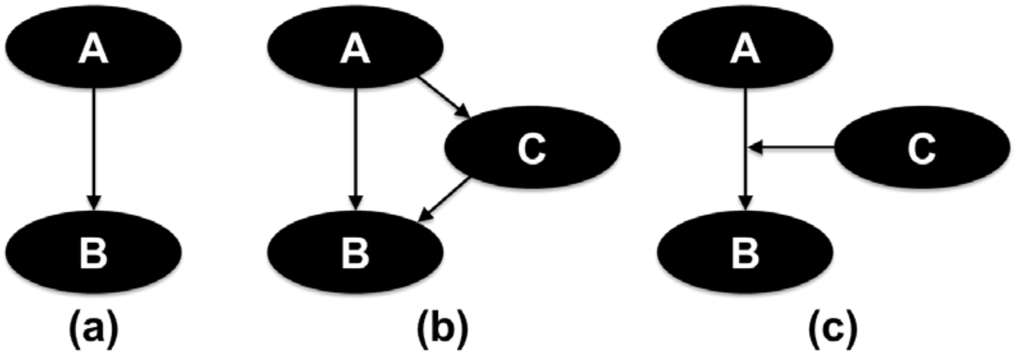

Figure 7. Direct model (a), mediator model (b), and moderator model (c)

An existing mediation effect would mean that the impact of *A* on *B* can be explained (at least partly) by *C*. In such a model *A* would affect *C* and *C* would affect *B*, instead or in addition to the direct effect from *A* to *B*. In case of partial mediation, *A* would have a lower but still significant effect on *B*; in case of full mediation *A* would not have a significant effect on *B* anymore. To assess the level of statistical significance of the mediation effect, Sobel's z-test is most often used (Baron and Kenney 1986; Shrout and Bolger 2002). However, newer research suggests bootstrapping the sampling distribution to avoid making any assumptions regarding the sampling distribution (Hayes 2009; Preacher and Hayes 2004).

A moderation or interaction effect assumes that no direct impact between *A* and *C* exists, but that *C* positively or negatively affects the impact from *A* on *B*. The latent variable *C* is also called moderator (Baron and Kenney 1986). An overview about different approaches for assessing moderating effects is given by Henseler and Chin (2010). In this thesis, the 2-stage approach suggested by Chin et al. (2003) was always used for evaluating interaction effects (i.e., **Paper V** and **Paper VIII**) as no superior approach for the assessment is currently available when both reflective and formative measurement models are involved (Henseler and Chin 2010).

3.3.2 Factor Analysis

In addition to evaluating the measurement model based on the results from SEM, it is also suggested that an assessment of the construct validity of newly developed (second-order) constructs using factor analysis is made (Straub et al. 2004). Basically, factor analysis is a technique to reduce the number of given variables to a smaller subset of variables that are independent of each other and are called factors (Bühl 2008). Factor analysis combines those variables which are highly correlated to aggregated factors; consequently variables belonging to different factors do not correlate highly (Bühl 2008).

One can identify two kinds of factor analysis: confirmatory factor analysis (CFA) and exploratory factor analysis (EFA). In CFA the number of factors is fixed before running the analysis while in EFA the number of factors is determined by the algorithm. The most common approach for factor analysis is the principal component analysis (PCA), which was also applied in this research, as PCA is suggested for investigating the construct validity of newly developed constructs (Straub et al. 2004).

Running an EFA with PCA reveals the Eigenvalues of each factor, where a larger Eigenvalue of a factor means that a larger share of the total variance is explained by that particular factor. The usual guidelines state that the Eigenvalues should be at least equal to 1 and loadings of each item on its factor should be at least .40 while having lower cross-loadings on the other factors to ensure that construct validity is met (Straub et al. 2004). However, it is also common to additionally investigate the scree plots for identifying underlying factors or to extract those factors that are interpretable (Backhaus et al. 2008). In addition, applying varimax rotation is the most common technique to support the interpretation of the identified factors (Bühl 2008).

3.3.3 Cluster Analysis

Cluster analysis is a technique to identify groups (i.e., clusters) among data (i.e., participating organizations) with respect to specified variables (i.e., items). As multiple variables can be used simultaneously to identify the clusters, cluster analysis belongs to the multivariate techniques, as also factor analysis and SEM do. The result of a cluster analysis is that the characteristics of all organizations assigned to one group show similar characteristics with respect to the specified items and that each group differ from the other groups according to these items (Sharma 2008). As the number of clusters is a priori not known, cluster analysis belongs to the exploratory approaches.

Following Malhotra et al. (2005) and Rai et al. (2006), a two-stage approach that combines hierarchical and non-hierarchical clustering methods was used in this research. In the first stage of the cluster analysis, we conducted hierarchical clustering using Ward's method based on the squared Euclidean distance, "which tries to minimize the total within-group or within-cluster sums of squares" (Sharma 2008, p. 193), to determine the number of clusters. The final number of clusters was determined by assessing the coefficients created by Ward's method as well as the dendogram (Malhotra et al. 2005) and the means. In the second stage, the non-hierarchical K-Means algorithm was used to assign every participating organization to one of the identified clusters.

4 Main Results

In the following, each paper of this cumulative dissertation thesis is described and the main results are presented.

4.1 Paper I[5]

The first paper of this cumulative dissertation thesis conducts a review of the literature, as "literature reviews serve as *the* means to reveal open research gaps and are part of a larger research endeavor" (vom Brocke et al. 2009a, p. 11). The underlying research question of this paper is:

RQ1: What are important research directions for investigating SOA from a business perspective?

Therefore, **Paper I** is presented in accordance with general guidelines for literature reviews (Webster and Watson 2002) and follows a structured literature review approach (vom Brocke et al. 2009a) as described in section 3.1. Analyzing 40 research works (17 journal articles, 20 conference papers, and three books) published between 2000 and 2009 the literature review synthesizes existing research in the field of SOA from a business perspective. Thereby it integrates previous results to offer an overview of the existing body of knowledge as well as proposing a research agenda, which unifies and extends previous efforts. The only journals out of the top 25 research journals (Lowry et al. 2004) as well as the one practitioner journal publishing SOA articles relevant for this literature review are the *IBM Systems Journal* (8 articles), *Wirtschaftsinformatik* (6 articles), and *Communications of the ACM* (3 articles).

Overall, four different areas of SOA research are investigated: *characteristics of SOA*, *adoption determinants*, *governance mechanisms*, and *business impact*. The main results for each of the four areas are as follows:

- The *characteristics of SOA* are mainly based on sources following conceptual or argumentative deductive research methods. The different characteristics identified in the literature can be grouped into three subcategories. The first category consists of technologies used for implementing an SOA. The second category captures common design principles applied in an SOA. The last category shows principles used to establish an SOE (Janssen and Joha 2008; Vitharana et al. 2007). Overall, the extracted intersection of aspects can be interpreted as a common understanding regarding the characteristics of SOA and the large number of papers investigating SOA's characteristics shows that this area is well-researched.
- Retrieving empirical articles that allow judgments regarding the adequacy and importance of *SOA adoption determinants* shows sparse results. Besides two papers that offer limited insights into particular determinants, only two papers investigate the drivers and inhibitors of an organization's decision to adopt SOA comprehensively (Tewary et al. 2009; Yoon and Carter 2007). The dominant research methodology of this area is case study research. However, none of the papers investigating SOA adoption applies an underlying theory or framework for developing their research model.
- For investigating the field of *SOA governance* six empirical papers could be found. Notably, four of the identified articles comprehensively investigate nearly every aspect that could be identified in the body of the literature (Bieberstein et al. 2005a; Tewary et al. 2009; Walker 2007; Yoon and Carter 2007). But, even though research in this area is less

[5] Joachim, Nils (2011): "A Literature Review of Research on Service-Oriented Architectures (SOA): Characteristics, Adoption Determinants, Governance Mechanisms, and Business Impact", in: *Proceedings of the 17th Americas Conference on Information Systems (AMCIS)*, Detroit, MI, USA.

fragmented, the existing literature does not explicitly use any of the existing SOA governance frameworks to structure its research regarding SOA governance.

- Overall 12 articles could be identified that offer empirical insights into the actual *business impact* of SOA. From these articles, one used expert interviews (Becker et al. 2009), four applied a quantitative research design (Kumar et al. 2007a; Kumar et al. 2007b; Oh et al. 2007; Tafti et al. 2008), while the remaining seven articles investigated the business value of SOA using case studies. While the majority of the identified papers focus on investigating particular benefits, the results of the expert interviews (Becker et al. 2009) as well as two of the case study articles (Baskerville et al. 2005; Yoon and Carter 2007) reflect a quite complete view of the actual benefits achieved by adopting SOA in organizations. Similar to SOA adoption determinants and governance mechanisms, this research field lacks a common theoretical foundation and overarching categorization of the different identified aspects.

The literature review synthesized the existing research from 40 research works on SOA from a business perspective and offers a categorized overview about the existing body of knowledge as well as offering directions for future research. Also, theoretical foundations and related research for addressing the proposed research questions are given to support scholars interested in SOA. The core of the proposed agenda is the suggestion to develop a unified measurement model to capture SOA's multidimensionality and the subsequent use of this to further investigate the other areas of SOA research applying quantitative research methods to understand SOA's adoption determinants, its governance mechanisms, and its achievable business impacts by adopting SOA better. Therefore, research should investigate each of the fields holistically, covering the majority of the identified aspects of each research field as well as drawing on well-established theories and frameworks.

4.2 Paper II[6]

This paper responds to the issue identified by Vitharana et al. that "future research should investigate organizational and industry characteristics that influence adoption of the service paradigm" (2007, p. 8). Thus, as we could not find a comprehensive concept for measuring SOA adoption in the literature to measure SOA adoption in quantitative research, this paper first assesses SOA's characteristics to conceptualize SOA adoption and consequently develops a measurement instrument to answer the first research question:

RQ2a: How can SOA adoption be conceptualized and measured?

To capture the degree of SOA adoption in an organization holistically, our conceptualization of SOA unifies previous definitions and conceptualizations by drawing on the concept of EA (cf. section 2.1) to capture the degree of service orientation in each of the following three architecture layers as proposed by TOGAF 9: business architecture, IS architecture, and technology architecture. Additionally, we investigate the fit of service orientation between these three architecture

[6] Joachim, Nils; Beimborn, Daniel; Weitzel, Tim: "What Drives Service-Oriented Architecture Adoption? Technological, Organizational, and Environmental Drivers and Patterns of SOA Adoption", different parts of this research have been presented and discussed at *three Pre-ICIS workshops* (Joachim et al. 2009; Joachim et al. 2010a; Joachim et al. 2010b) as well as at the *doctoral consortium at ICIS* (Joachim 2009).

layers to assess vertically the fit and actual use of SOA within all layers. Thus, we capture SOA adoption using the following four dimensions:

(1) *Service-oriented business architecture*: The degree of service orientation of the business architecture (i.e., SOE) is captured by investigating whether business activities are designed and managed following a service-oriented paradigm within the business layer. For example, services-based modeling concepts for modeling business processes should be used to identify the core capabilities of an organization (Ernest and Nisavic 2007; König et al. 2005). Also, an organization with a high degree of service orientation in the business architecture should be organized in shared service centers such that it is able to offer and run centralized and non-redundant (shared) business services (Janssen and Joha 2008).
(2) *Service-oriented IS architecture*: This aspect captures the extent to which the architectures of business application systems are in line with the service-oriented paradigm. Typical design principles to achieve service orientation at the entire system landscape include loose coupling, composability, and the division of reusable logic (Erl 2005).
(3) *Service-oriented technology architecture*: The extent of service orientation of the technology layer is investigated with respect to using technologies related to implementing SOA, for example, XML, Web Services, ESB, service registry/repository, and business process execution language (BPEL) (Kumar et al. 2007b; Oh et al. 2007).
(4) *Fit of service-oriented architectures*: In addition to investigating each of the three proposed layers of EA separately, it is also important to assess the alignment of each of these architectures. Thus, this additional dimension assesses the degree to which SOA is used (in terms of each of the three dimensions described just above: (1), (2), and (3)) to support particular business processes in the organization. This dimension thus assesses the fit of the three architectures, as business processes can be implemented only using service orientation if all three architecture layers are aligned for that particular business process.

This multidimensional SOA research concept, which is based on the well-established concept of EAs, integrates the various definitions and conceptualizations found in the literature (cf. section 2.1). Moreover, it supports defining a comprehensive measurement model consisting of 16 single items to capture empirically a more complete picture of the degree of SOA adoption and, consequently its influencing factors as well as its impact. The four dimensions of the measurement model are further supported by the results of an exploratory factor analysis and as all weights of the formative indicators of the multidimensional holistic SOA adoption construct are substantial and significant, the usefulness and applicability of all SOA dimensions is highly supported by the empirical data of 154 organizations. Based on this concept, this paper provides a holistic multidimensional instrument for measuring SOA adoption that is successfully applied in quantitative research, which may be adopted, used, and improved in further empirical SOA studies.

Next, the developed multidimensional SOA research concept is used for a cluster analysis to identify different patterns of SOA adoption:

RQ3a: What distinct SOA adoption patterns can be observed?

Based on the data of 154 organizations, Figure 8 shows the results of the cluster analysis that identified five different approaches to SOA adoption (from no adoption to a holistic SOA approach) associated with the different dimensions of the multidimensional SOA adoption instrument. Identifying these five SOA adoption patterns increases our understanding of how the EAs of organizations are moving towards service orientation. While about one-fourth of the organizations investigated have not adopted SOA at all, another 23 percent has thus far limited their service-oriented activities to the business architecture, while 18 percent have reached a medium degree among all SOA dimensions. The last third (Clusters 4 and 5) has reached a comparably higher level of comprehensive service orientation in their EA.

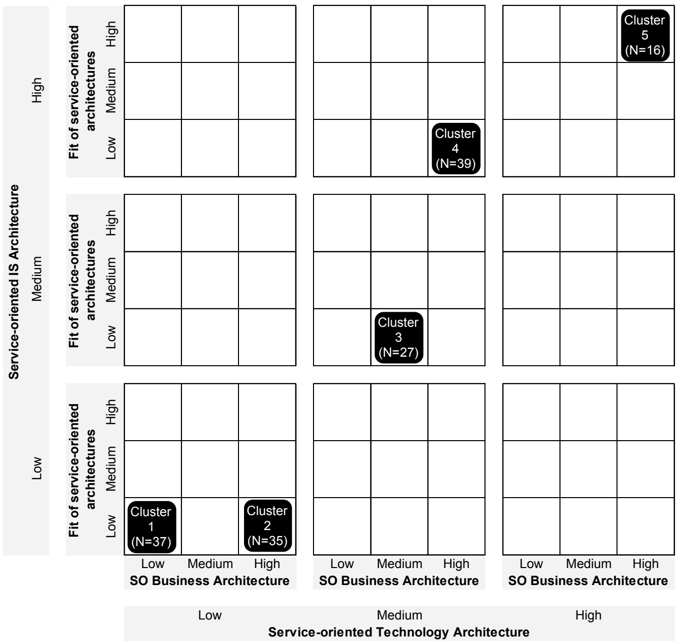

Figure 8. Identified SOA adoption patterns

As no theoretical model exists in the literature to investigate drivers and inhibitors of SOA adoption, an adoption model based on the TOE framework (DePietro et al. 1990) is developed to explain why firms use SOA and what they need to adopt SOA, which leads to a further research question:

RQ3b: What factors influence SOA adoption?

Therefore, the literature was reviewed again and 38 studies applying the TOE framework were identified. The comprehensive review these studies applying the TOE framework gives an overview of the different factors used as well as their significance in past empirical studies. Based on the results of these studies that investigate the adoption of technologies at organizations as well as on the results of previous research on SOA, the TOE framework was adapted to the context of SOA (Figure 9):

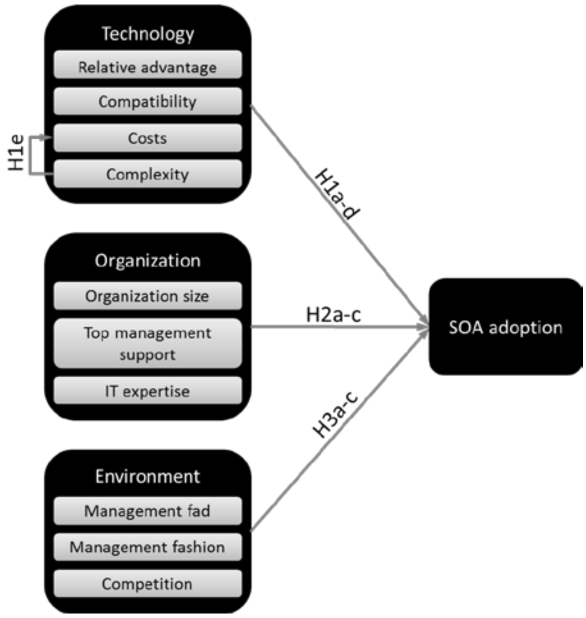

Figure 9. Research model for investigating SOA adoption

The results from testing the research model with SEM using the data of 154 organizations extend our knowledge of why firms adopt SOA and what they need to achieve a high degree of SOA adoption. SOA adoption is based predominantly on organizational prerequisites such as IT employees' IT expertise, top management support, and the compatibility of SOA with an organization's IT setting. Further determinants are relative advantage, costs, and organization size. The research model includes management fashion and fad (Abrahamson 1991; Abrahamson 1996) as they are proposed to be promising aspects for future, more innovative studies of IS innovation (Fichman 2004; Robey et al. 2008). The results show that an organization's SOA adoption is also influenced by observable SOA adoption from other firms ("same group", i.e., managemet fad) and from media, consultants and other sources ("outside group", i.e., management fashion). Notably, the complexity of implementing SOA is seen as a cost driver but not as an inhibitor. Overall the TOE-based determinant model explains a substantial part of SOA adoption (R^2 = 63.7%), which indicates the appropriateness of our theoretical adaptation of the TOE framework to the context of SOA adoption. Our empirically evaluated SOA adoption model contributes to the literature on both SOA and organizational adoption of IT-related innovations.

4.3 Paper III[7]

Vitharana et al. (2007, p. 3) propose that "service orientation helps to execute the business strategy of an enterprise with significant multi-dimensional benefits (flexibility to change, enhanced quality, effectiveness), in less time (time-to-value) and cost (efficiency) using IT". However, there is still no empirical study that assesses the business value of SOA comprehensively. In addition, the results of a literature review show that the organizational impact of SOA is by far the least researched area; it is the subject of only 19 of 175 SOA papers identified (Viering et al. 2009). Thus the underlying research question of this paper is:

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[7] Joachim, Nils; Beimborn, Daniel; Weitzel, Tim: "The Business Value of SOA: An Empirical Evaluation of the Impact of Service Orientation on Business and Technical Goals", a previous version has been published in *Proceedings of the 10th International Conference on Business Informatics (WI)*, Zurich, Switzerland (Joachim et al. 2011a).

RQ4a: What is the business value of SOA?

This paper applies the multidimensional SOA concept developed in **Paper II** and develops, based on the findings of **Paper I**, a multidimensional SOA business value concept comprising the business impacts found in the literature on SOA. The variety of different potential advantages that, in general, can be realized by SOA, and the fact that such advantages are often not directly reflected in financial ratios (Shang and Seddon 2002; Uwizeyemungu and Raymond 2009), necessitate a multidimensional evaluation of SOA's value contribution.

Using the data from 162 organizations, we not only analyze the direct impact of SOA on these benefits, but, by drawing on dynamic capabilities theory (Teece et al. 1997), add IT flexibility (Byrd and Turner 2000; Chanopas et al. 2006; Duncan 1995) to the model as a mediating variable to further explain this basic proposition. Finally, we investigate the role of service reuse, which is often mentioned as the main intermediary goal in this context (Papazoglou and Heuvel 2007; Ren and Lyytinen 2008).

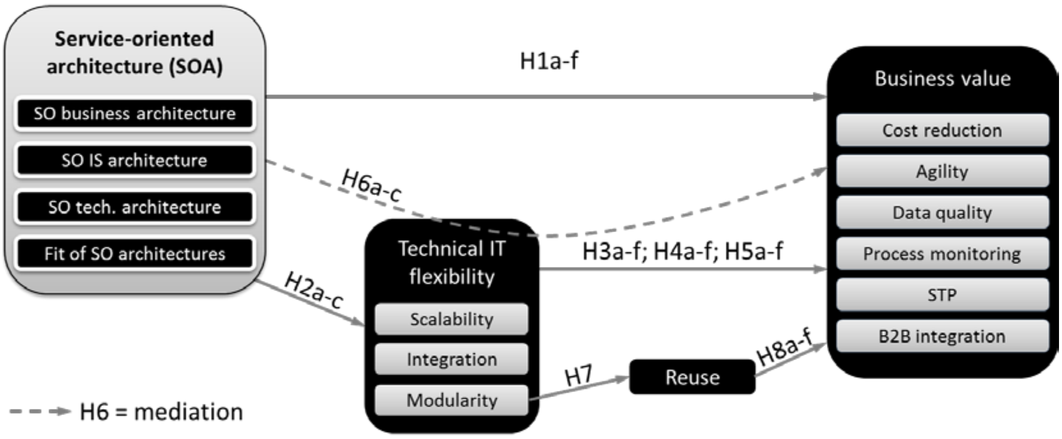

Figure 10. Research model for examining SOA's business impact

Paper III has four main results:

- Using SOA has a significant business impact by contributing to business value in terms of reducing costs and increasing business agility, data quality, process monitoring, internal STP, and business-to-business (B2B) integration of processes.
- SOA is positively related with IT flexibility, with a strong impact on modularity and integration and a weaker relationship with scalability. SOA's primary intent is to modularize business activities and the underlying IT implementations to integrate them more effectively, more efficiently, and more flexibly to serve the firm's business needs. In addition, the increased IT flexibility resulting from SOA contributes strongly to all six benefits. However, the results also show that SOA accounts for only a limited proportion of IT flexibility. The highly significant path coefficients substantiate that SOA is an effective option to achieve a high degree of IT flexibility; however, organizations are also able to implement a flexible IT without using SOA.
- Analyzing the role of IT flexibility as a mediator of SOA's value contribution to the different business benefits overall confirms that SOA's business impact is based mostly on classical aspects of IT flexibility (i.e., modularity, integration, and scalability) or – theoretically speaking – to dynamic capability.
- The results reveal that adding reuse to the model does not offer any additional explanations about how SOA generates business value. We can conclude that reuse is achieved

by SOA and a higher degree of modularity is a key enabler of reuse, but that business value of SOA is, notably, not driven by reuse of functionality (yet).

4.4 Paper IV[8]

In addition to assessing the extent of SOA adoption using the four dimensions (service-oriented business, IS, technology architecture, and fit among these architectures), we propose measuring the degree of SOA *maturity* in future empirical research especially in the context of SOA business value. According to a Gartner survey (Sholler and Schulte 2009, p. 1) "companies at higher levels of SOA maturity achieved payback faster, realized higher degrees of developer productivity, agility and innovation, and had higher degrees of asset reuse." Thus, being able to measure SOA maturity in survey-based research allows researchers to substantiate these claims and to evaluate the impact of increasing SOA maturity. Accordingly, this paper is guided by two research questions:

RQ2b: How can the maturity of an SOA implementation be measured?

RQ4b: What is the business value of SOA maturity?

Many different SOA maturity models have been proposed in the literature, for example, the Service Integration Maturity Model (SIMM) (Arsanjani and Holley 2005), the Combined SOA Maturity Model (CSOAMM) (Söderström and Meier 2007), the Independent SOA Maturity Model (iSOAMM) (Rathfelder and Groenda 2008), the SOA Maturity Model (Hirschheim et al. 2010), or The Open Group Service Integration Maturity Model (OSIMM) (The Open Group 2009a). However, no SOA maturity model exists that has been operationalized for quantitative research, and usable items and scales for evaluating the particular maturity level of an organization do not exist. To operationalize SOA maturity we draw on the OSIMM, as compared to the other maturity models, the OSIMM allows for the most complete and most detailed assessment of SOA maturity considering both business and IT aspects as well as comparing the maturity along different dimensions.

Our analytical approach uses 21 criteria to classify the maturity of an organization's SOA in seven maturity levels along seven maturity dimensions (3 items for each dimension) derived from the OSIMM. The applicability of this new instrument is shown using data from 121 organizations.

For assessing which of OSIMM's seven maturity levels has been reached, and to what degree, by a particular organization, we calculate the squared statistical distance to each of the seven maturity levels using the characteristic values of 21 items that capture the theoretical profiles of the seven maturity levels. The squared statistical distance, $SSD_k^2(Level\ l)$, of a particular organization k to a specific SOA maturity level l is the sum of the differences between the answers of the organization to specific items i, x_{ki}, and the characteristic values for those items for the specific maturity level, x_{li}, weighted by the standard deviation of that item s_i:

$$SSD_k^2(Level\ l) = \sum_{i=1}^{21} \left(\frac{x_{ki} - x_{li}}{s_i}\right)^2$$

[8] Joachim, Nils; Beimborn, Daniel; Weitzel, Tim: "An Instrument for Measuring SOA Maturity", a previous version has been published in *Proceedings of the 32nd International Conference on Information Systems (ICIS)*, Shanghai, China (Joachim et al. 2011b).

At the end, for each organization k seven squared statistical distances are calculated – one for each SOA maturity level l with the respective characteristic maturity level values x_{li}. Finally, the organization is categorized by the SOA maturity level to which it shows the lowest squared statistical distance.

The main results of this paper are:

- The paper offers a new instrument for measuring SOA maturity in quantitative research. The new maturity variable can, for example, be used for group comparisons in regressions, SEM, or other statistics.
- Determining the SOA maturity for the organizations participating in our study reveals that no single organization has achieved an overall SOA maturity according to the highest levels 6 or 7. The majority of the participants have mainly reached SOA maturity levels between 2 and 4. Organizations operating in IT & communications or financial services are shown to have more mature SOAs.
- Lastly, the analysis shows that increasing levels of SOA maturity increase business agility and STP while lowering IT costs. Also the analysis indicates decreasing marginal benefits of higher levels of SOA maturity for STP as well as stagnation of business agility from level 3 to 4. Thus, increasing the level of SOA maturity from level 3 to 4 does not increase business agility and in the case of STP the higher level of SOA maturity results in a lower increase of STP from level 3 to 4 in comparision to the increase from level 2 to 3.

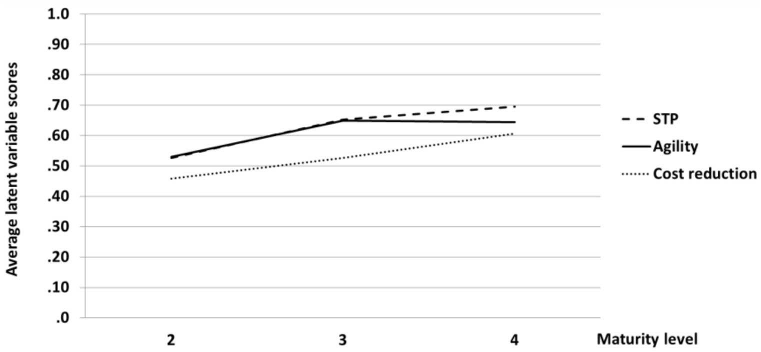

Figure 11. Average latent variable scores with respect to achieved maturity level

4.5 Paper V[9]

This paper empirically evaluates SOA's potential to leverage the impact of BPM on a firm's process quality and efficiency. Previous research has noted that the "partnership of BPM and SOA has been fruitful by merging the benefits of both sides" (Bajwa et al. 2009, p. 677). Our paper is among the first to face the "need for more empirical studies in the context of BPM" claimed by Ho et al. (2009, p. 9) after he had reviewed all 37 BPM journal articles published between 2000 and 2008 in the ten Top IS journals.

BPM is expected to benefit from SOA as many business processes heavily depend on the underlying IT and SOA can enable firms to implement the designed business processes on the IT layer

[9] Beimborn, Daniel; Joachim, Nils (2011): "The Joint Impact of Service-Oriented Architectures and Business Process Management on Business Process Quality: An Empirical Evaluation and Comparison", in: *Information Systems and e-Business Management (ISeB)*, (9:3), pp. 333-362.

(Bajwa et al. 2009; Brahe 2007; Smith and McKeen 2008; Woodley and Gagnon 2005). Therefore, BPM and SOA together can support firms in optimizing business processes and reaching superior process quality. Subsequently, we address the following research question:

RQ4c: What is the interplay between BPM and SOA for achieving business process quality?

Drawing on data from our SOA survey (n = 154), we empirically evaluate how BPM and SOA jointly affect business process quality in terms of increased B2B integration, STP, standardization/consolidation, and quality control.

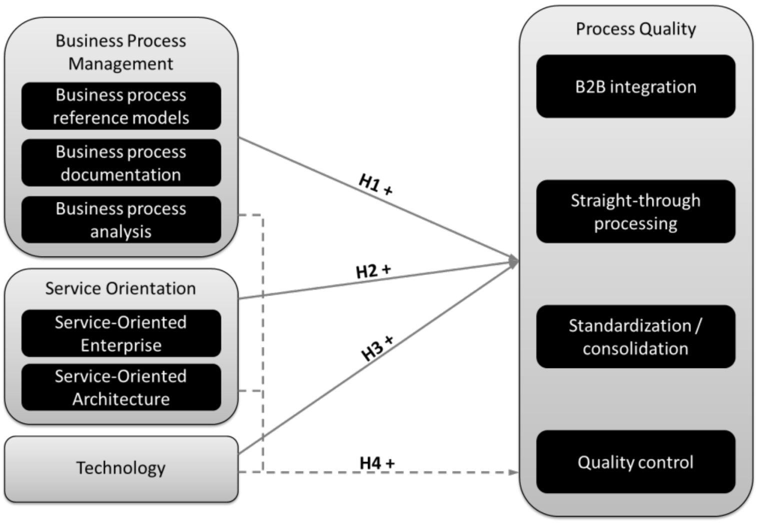

Figure 12. Research model for analyzing the interplay between BPM and SOA

Business process management (BPM) combines tools and methods to increase the effectiveness and efficiency of business processes. While it has become a popular approach to gain competitive advantage (Hung 2006), empirical research regarding its value contribution is still sparse, yet necessary (Ho et al. 2009). Moreover, new architectural paradigms, such as SOA, are increasingly adopted by organizations and offer new opportunities to BPM (Bajwa et al. 2009; Smith and McKeen 2008). For conceptualizing BPM, we consolidated Zairi's (1997) BPM "rules" into three key aspects, i.e., the use of (1) reference models, (2) business process documentation, and (3) business process analysis.

For conceptualizing business process quality, we draw on the Juran Trilogy (Juran 1986) which is a popular perspective of total quality management (TQM) (cf. Powell 1995) and consists of (1) quality planning (e.g., set goals), (2) quality control (e.g., evaluate performance), and (3) quality improvement (e.g., establish infrastructure). As the first component of the trilogy, i.e., quality planning, is an antecedent and not a part of business process quality, our dependent variable business process quality draws on (2) and (3) only. *Quality control* is manifested by the implementation of process monitoring activities. Juran's last dimension of "improvement" is conceptualized in more detail by three further dimensions: *B2B integration*, *straight-through processing (STP)*, and *standardization & consolidation* of business processes. Therefore, our four process quality dimensions cover those two phases of Juran's trilogy which follow the quality planning phase.

The results of Paper V are summarized as follows:

- There is a positive interaction effect (i.e., complementarity) between BPM and the implementation of SOA towards business process quality. However, the role of service orientation proves to be somehow limited, while the impact of BPM and related IT (XML, Web Services, ESB, registry/repository, BPEL, business activity monitoring (BAM), or business rules engines) is very clear.

- The impact of service orientation is (comparatively) strongest towards process quality's subdimensions of standardization & consolidation and B2B integration. These are the main dimensions to which SOA can contribute, by identifying redundant business activities and by supporting the integration of external services from B2B partners within the organization's value chain.
- Both BPM and supporting technologies are the most important drivers of business process quality, as they contribute to every single dimension of process quality directly.

4.6 Paper VI[10]

BPO represents the delegation of a particular business activity or an overall business process, including the related supporting services, to an external provider (Gewald and Dibbern 2009), and often also covers the transfer of the necessary resources, such as IT systems and applications supporting the outsourced business activity. However, it is – in contrast to IT outsourcing or software outsourcing – not about serving the IT functions or running the software applications per se, but about delivering a business process result.

Most research on BPO draws on the IT outsourcing research strand. Usually, research follows the established (IT) outsourcing models and empirically identifies determinants and inhibitors of BPO adoption (Gewald and Dibbern 2009; Gewald et al. 2006), determines the outcomes of BPO (Willcocks et al. 2004), or investigates the role of BPO success factors (Wüllenweber et al. 2008), such as effective control and governance structures (Kim and Kim 2008; Mani et al. 2006), effective sourcing mechanisms (Tanriverdi et al. 2007), and client firm-internal BPO readiness (Martin et al. 2008).

While, previous research shows that increased product modularity not only eases outsourcing but also helps to distinguish between strategic and non-strategic components (Ernst and Kamrad 2000; Momme et al. 2000), only a few articles have focused on the role of IT for successful BPO. This is particularly interesting as business processes become increasingly IT-intensive and Davenport (2005) emphasizes that standard interfaces between information systems allow easier outsourcing of business activities. In addition, Abramovsky and Griffith (2006) conclude – based on their empirical study – that organizations which use more IT outsource more services. Therefore, because the influence of IT modularization on BPO seems to be a neglected perspective, we investigate the influence of SOA on BPO:

RQ4d: Does SOA facilitate BPO?

From a BPO perspective, the analysis reveals the extent to which technical and organizational architecture is a BPO driver and/or readiness factor. BPO is related with certain advantages, such as cost advantages (Gewald and Dibbern 2009) and quality improvement, as well as certain risks (e.g., friction costs or loss of performance or quality) (Aubert et al. 1999; Aubert et al. 1998; Bahli and Rivard 2004; Cunningham 1967; Earl 1996; Gewald et al. 2006).

[10] Beimborn, Daniel; Joachim, Nils; Weitzel, Tim (2012): "Do Service-Oriented IT Architectures facilitate Business Process Outsourcing? A Study in the German Service Industry", in: Zeitschrift für Betriebswirtschaft (ZfB), Journal of Business Economics, (82:Special Issue 4), pp. 77-108.

An important issue when deciding upon outsourcing is the flexibility of the outsourcing engagement. If outsourcing is complex and difficult, there might be several technical, organizational, and contractual obstacles which do not allow for subsequent adaptations of the arrangement, for example, to changing processing volumes or new requirements. Tan and Sia (2006) define sourcing flexibility as the flexibility to change, extend, or reduce the BPO arrangement and to change service providers. Tan and Sia (2006) conceptualize sourcing flexibility as consisting of four dimensions: *modifiability* and *robustness* of the outsourcing relationship, extensibility about *new capabilities*, as well as *ease of exit*.

We hence propose a research model that highlights the role of a firm's internal IT architecture and its effects on BPO benefits, risks, and sourcing flexibility.

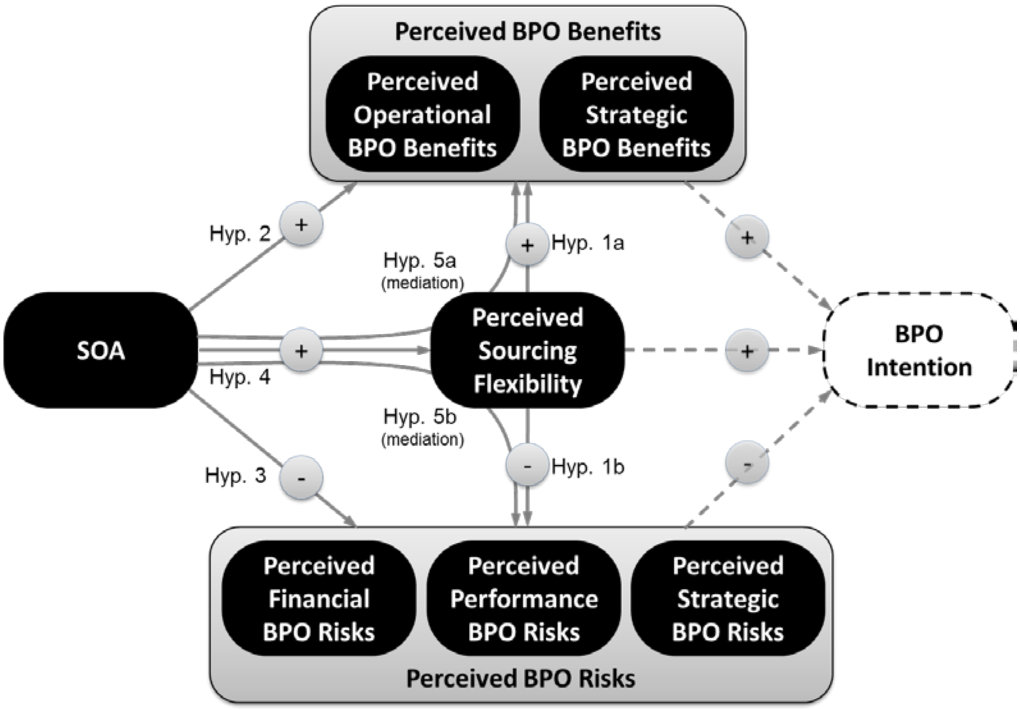

Figure 13. Research model for examining SOA's impact on BPO

The results that are based on the empirical data from 115 organizations can be summarized as follows:

- Strategic benefits do not seem to be a major argument in selective SOA-based outsourcing of single business functions. Strategic BPO benefits (core competencies focus, access to superior vendor know-how) can be achieved with or without SOA. Instead, the main pros are of an operational nature (cost reduction, quality and productivity improvement). The operational benefits are increased by SOA because SOA facilitates the separation of the particular business function from the client and its transfer to the vendor firm and it also – due to increasing modularity – facilitates selective sourcing of different business functions to different, best-suited vendors, which in turn can maximize economies of skill and scale (Beimborn 2008).
- From the outsourcing firm's perspective, loss of quality and performance usually are related to insufficient competencies or an absence of willingness to fulfill by the outsourcing vendor. Since SOA only facilitates outsourcing from a technical and organizational perspective but does not avoid the threat of selecting an incapable partner, it does not re-

duce this perception of performance risks. But, due to increased modularity and more selective sourcing, SOA reduces the strategic risks of lock-in since backsourcing or changing the vendor will be easier in the event of poor performance.

- Sourcing flexibility only slightly mediates the relationship between SOA and operational benefits, financial risks, and strategic risks. Sourcing flexibility is an explanation factor of why SOA increases perceived BPO benefits and reduces perceived BPO risks but there remains space for additional complementary explanations. One of these could simply be the fact that SOA leads to a more modular perspective on doing business. A modularity perspective on how a firm generates value opens the eyes to outsourcing opportunities – just as product modularization increased outsourcing and industrialization in manufacturing processes several decades ago. Another argument is related to the technical level: SOA involves standards which allow the interaction and integration of the implemented business services. Using standards increases opportunities for inter-firm collaboration which also covers BPO opportunities.

4.7 Paper VII[11]

To realize the potential advantages of an SOA, implementing a comprehensive SOA governance is often proposed (Brown et al. 2006; Malinverno 2006; Varadan et al. 2008; Walker 2007). In addition, industry analysts perceive that the "main reason SOA projects fail is because there is a lack of governance" (Saran 2006). Even though academic research has successfully investigated technical aspects surrounding the development and implementation of SOA, it has left open what governance mechanisms are needed to realize the potential hidden in SOA. A recent literature review reveals that "organization and governance" is addressed in only 4 out of 175 SOA research articles identified (Viering et al. 2009). The authors conclude their summary of SOA research with a call for future research on "how organizations should apply the SOA concept" (Viering et al. 2009, p. 46). Thus, a relevant question for researchers and practitioners alike is how to achieve the benefits expected from adopting SOA in an organization.

While the benefits often mentioned include increasing IT flexibility (e.g., Kumar et al. 2007b; Yoon and Carter 2007) and services reuse to achieve cost decreases and increase enterprise agility (e.g., Baskerville et al. 2005; Yoon and Carter 2007), extending a firm's IT governance to embrace SOA is not trivial. To address this challenge, our research question is:

RQ5a: Which SOA governance mechanisms are important for SOA?

A review of the literature on SOA governance revealed that although many SOA governance mechanisms have been proposed in the academic and practitioner literature, to the best of our knowledge none of these concepts has been evaluated quantitatively to examine the role of governance mechanisms for an SOA implementation.

To select the SOA governance mechanisms investigated in our study, we followed a multi-staged approach. First, we selected two established governance models to identify important governance categories. The generic IT governance model of De Haes and Van Grembergen (2009) distin-

[11] Joachim, Nils; Beimborn, Daniel; Weitzel, Tim (2013): "The Influence of SOA Governance Mechanisms on IT Flexibility and Service Reuse", forthcoming in *Journal of Strategic Information Systems (JSIS),* http://dx.doi.org/10.1016/j.jsis.2012.10.003.

guishes between *structures*, *processes*, and *relational mechanisms*, while the conceptual SOA governance model suggested by Kohnke et al. (2008) draws on *structures*, *processes*, and *employees*. As both models draw on three comparable pillars, we decided to focus on these three categories. We did not want to limit our analyses to other, more narrowly focused SOA governance models that are based, for example, on a service lifecycle approach (e.g., Brown et al. 2006; Schepers et al. 2008) and thus omit other aspects of the SOA governance domain. In a second step, we conducted a review of the research literature to identify different SOA governance mechanisms that have been frequently proposed for each of the three categories. Figure 14 shows the developed research model, which investigates the seven most often mentioned SOA governance mechanisms found in the literature.

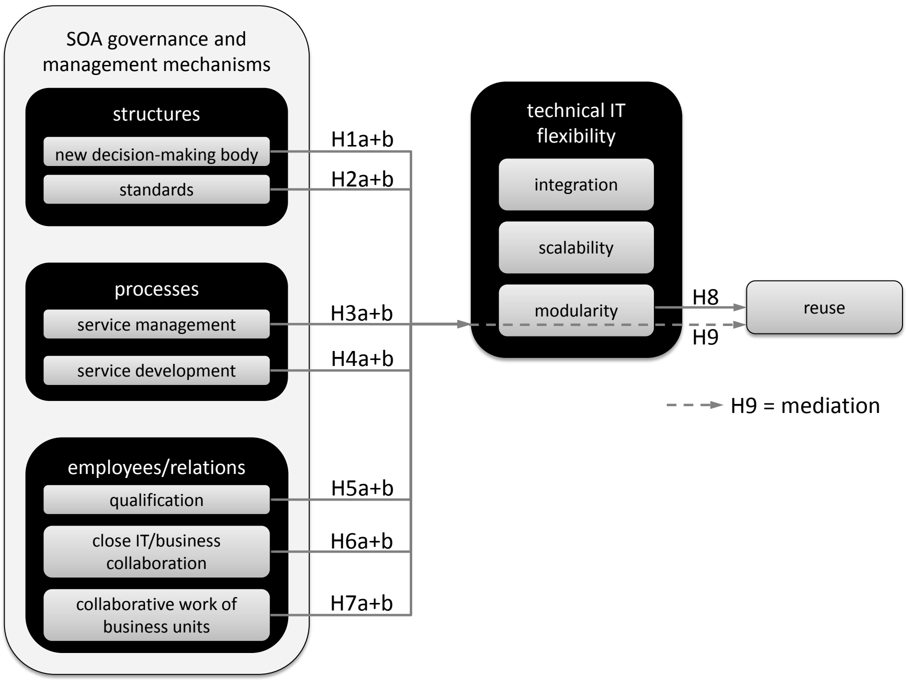

Figure 14. Research model for investigating SOA governance mechanisms

The research model is evaluated using the data of 81 SOA-using organizations leading to the following main results:

- Establishing new decision-making bodies such as SOA centers of excellence turns out to be of little utility. Rather, introducing SOA successfully relies more on the efficient use of any functioning decision-making body that may already have existed before SOA. This result supports the statement that establishing new decision-making bodies specifically for SOA is not a necessity in earlier phases of SOA implementations (Kohnke et al. 2008).
- Comparing the effects of SOA governance on the different dimensions of IT flexibility shows that scalability is less affected than modularity or integration. Using standards, educating employees, and IT/business communication are the only governance mechanisms contributing to all three dimensions of IT flexibility.
- Standards, clearly defined service management processes, and the qualification of IT personnel are vital for reusing existing functionality.
- The collaborative work of different business units supports the development of more modular services but does not increase integration, scalability, and the reuse of services directly. One possible explanation for this is that the increased collaboration will also in-

crease the complexity and thus make it more difficult to integrate or reuse services without the additional support of adequate processes (Windley 2007).

- Modularity is a partial mediator for the impact of the different SOA governance mechanisms on reuse.

4.8 Paper VIII[12]

This paper extends existing literature that identifies *what* possible benefits SOA can deliver, by adding a more theoretical perspective and analyzing *how* SOA delivers its benefits. Krafzig et al. (2005, p. 68) argue that "being able to talk about the specific nature of different services at an abstract level will enable the different stakeholders in an SOA project [...] to communicate their ideas and concerns more effectively". Also, Antikainen and Pekkola (2009, p. 1) highlight that "Service-Oriented Architecture (SOA) has gained focus as a driver for bridging and aligning business and IT-oriented views in information system development." Another role is pointed out by Yoon and Carter (2007, p. 1) suggesting "that SOA requires extremely high levels of organization-IT alignment to achieve reported benefits". These quotes distinguish two different roles when considering *how* SOA delivers its benefits: (1) The first two statements propose that SOA will improve IT/business collaboration and thus bring business and IT together. Hence, the common element of services that is introduced to an organization by implementing an SOA allows the reduction of the "mental gap" that exists between IT and business departments, so that they can work together more effectively and thus achieve the desired goals; (2) The last quote assumes that business and IT must work closely together to leverage SOA's full potential benefits. Thus, the first possibility for explaining SOA's value is its mediating role in close IT/business collaboration, while the second explanation assigns a moderating role to close IT/business collaboration. Consequently, the guiding research question is:

RQ5b: Does SOA create or require IT/business collaboration?

As theoretical foundation, the research model (Figure 15) applies the concept of shared mental models (SMMs) to examine the relationships between SOA and close IT/business collaboration. Close IT/business collaboration investigates how close and good business and IT work together at non-strategic levels. Thus, aspects like collaboration in projects and operations are analyzed (Byrd and Turner 2000; Chung et al. 2003). SMMs are concerned with an organizational understanding or mental representation of knowledge with regards to key elements of a work group's environment (Mohammed et al. 2000). Mathieu et al. (2000) have proposed distinguishing between two categories of SMMs: task and team. Task SMMs refer to team members holding a common schema of the task itself and, at the same time, having an understanding of how the environment may influence the task demands. Team SMMs exist if there is a shared understanding between the team members and how they are expected to interact (Mathieu et al. 2000; Mathieu et al. 2010).

Close IT/business collaboration can on the one hand act as an enabler (or moderator) for SOA's contribution to IT flexibility, since tight collaboration between IT and business is required to leverage SOA's benefits. On the other hand, we propose that implementing the concept of services

[12] Joachim, Nils; Beimborn, Daniel; Schlosser, Frank; Weitzel, Tim (2011): "Does SOA Create or Require IT/Business Collaboration? Investigating SOA's Potential to Reduce the Gap Between IT and Business", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*, Shanghai, China.

throughout the firm leads to the formation of a shared mental model, driving mutual understanding and thus increasing collaboration between IT and business. When business activities are modeled in a service-oriented manner, services are the main structuration and design concept serving as a task SMM. This will lead to more effective communication and fewer misunderstandings between business and IT employees (i.e., a team SMM). In turn, this will help achieve a more effective SOA (in terms of IT flexibility).

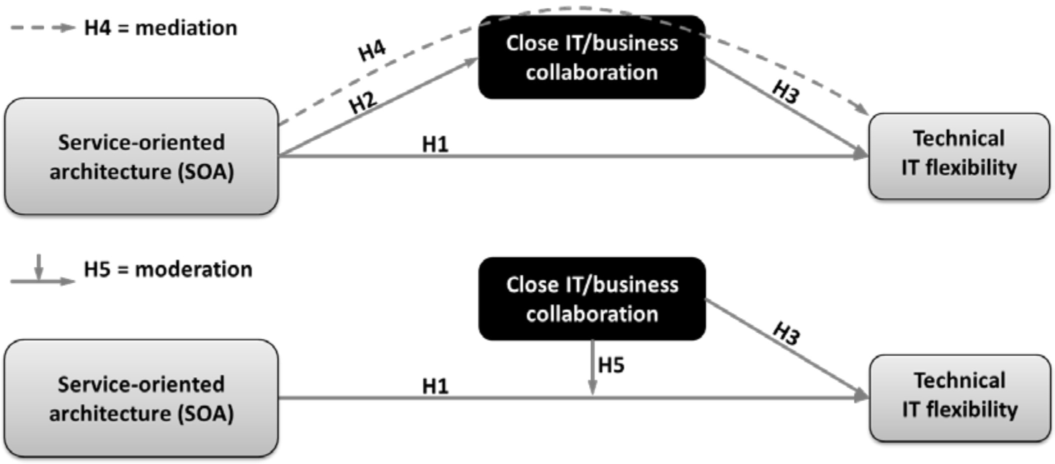

Figure 15. Research models for examining close IT/business collaboration as mediator (top) and moderator (bottom)

Both research models are evaluated using the data of 122 organizations. The main results are:

- SOA increases IT flexibility as well as close collaboration between IT and business departments, which in turn positively impacts IT flexibility.
- Even though the literature argues that SOA might facilitate establishing a shared language and a shared understanding (or: "shared mental models") between IT and business departments, the empirical results provide only marginal support that a close IT/business collaboration mediates SOA's impact on IT flexibility.
- By contrast, regarding close IT/business collaboration's role as moderator, the results support that IT/business collaboration is an important factor for leveraging SOA's organizational impact.

5 Contributions and Implications

The following subsections summarize the contributions to theory as well as managerial implications emerging from this cumulative dissertation thesis.

5.1 Contributions to Theory

The eight papers offer various contributions to theory with respect to the three research directions of this cumulative dissertation thesis:

Adoption: Why and under what circumstances do organizations introduce SOA? Five different approaches to SOA adoption are identified (**Paper II**): no SOA adoption, service-oriented business architecture, medium extent among all four SOA dimensions, medium extent with high service orientation of IS architecture, and high extent among all four SOA dimensions. This increases our understanding of how an organization's enterprise architecture is moving towards service orientation. Another contribution is the theoretical application of the TOE framework to the context of SOA adoption that extends our knowledge of why firms adopt SOA and what they need to achieve a high degree of SOA adoption. SOA adoption is based predominantly on organizational prerequisites such as IT employees' IT expertise, top management support, and the compatibility of SOA with an organization's IT setting. Further determinants are relative advantage, costs, and organization size. Notably, the complexity of implementing SOA is seen as a cost driver but not as an inhibitor. Also, this dissertation examines the role of management fashion and fad in an IT adoption context as proposed by other researchers (Fichman 2004; Robey et al. 2008). The results show that an organization's SOA adoption is also influenced by observable SOA adoption from other firms ("same group", i.e., managemet fad) and from media, consultants and other sources ("outside group", i.e., management fashion). Further, the comprehensive review of 38 studies applying the TOE framework gives an overview of the different factors used as well as their significance in past empirical studies. This summary of previous TOE research can guide other researchers investigating the adoption of IT-related innovations at the organizational level. Further, the review reveals that our study is the first application of the TOE framework to an IT architecture context. Also, the newly developed and tested multidimensional holistic research concept and instrument for SOA, which is based on well-established enterprise architecture frameworks covering the business, IS and technology architectures as well as the fit between these three architectures extends the existing literature and may be adopted, used, and improved in future empirical SOA studies.

Business impact: What are the benefits resulting from SOA? This thesis offers a theoretical and empirical explanation for SOA's business impact. The results substantiate the oft-proclaimed business value discussion of SOA by showing quantitatively significant relationships between the degree of SOA and business-relevant value dimensions in terms of reducing costs and increasing business agility, data quality, process monitoring, internal STP, and B2B integration of processes (**Paper III**). Also, this is the first study that conceptualizes and empirically evaluates a measurement instrument for BPM and offers first insights into how BPM and SOA jointly affect business process quality, which also contributes to BPM research that largely neglected a quantitative methodology in the past (**Paper V**). So far, such analyses have been restricted to case studies. Moreover, we advance the explanation how SOA contributes to IT flexibility in terms of modularity, integration, and scalability. Also, we offer a theoretical foundation by drawing on the concept of dynamic capabilities to argue theoretically and to show empirically that IT flexibility is a meaningful explanatory factor.

Another contribution to this research direction is the operationalization of an already existing SOA maturity model (i.e., OSIMM) for measuring SOA maturity in quantitative research (**Paper IV**). Applying the instrument offers new insights into SOA's business value, such as diminishing marginal utility of increasing SOA maturity. In the future, SOA researchers (e.g., investigating the business value of SOA or of a more mature SOA) can use the developed and tested instrument and apply the 21 SOA maturity items in their own survey-based research.

The business impact of SOA is further investigated by offering a new perspective on how the modularity of the IT architecture affects the redesign of organizational structures and eventually firm borders. Therefore, the arguments from two different research domains are combined: the business impact of SOA and the quest for IT-related BPO success factors (**Paper VI**). Regarding BPO research, the results extend the findings of previous studies on the drivers and inhibitors of

BPO by revealing the role of architecture, in particular SOA. For SOA research, we offer a first empirical evaluation of a business value aspect of SOA, which has not been investigated so far (i.e., facilitation of BPO).

Governance: How should SOA introduction and management be governed to achieve the benefits? This thesis offers an evidence-based contribution to the discussion of the role of SOA governance mechanisms and a validated measurement model that is useful when bringing together managerial and technical perspectives regarding service orientation (**Paper VII**). These can help future research to advance the theoretical and business foundations of the services concept and disclose relations between technical and organizational goals and how both can be achieved. Moreover, empirical evidence is provided for discussing whether implementing SOA establishes a shared mental model and mutual understanding between IT and business departments (**Paper VIII**). Thus, this thesis advances existing research, which is based on case studies, by providing evidence on a broad empirical base that the moderation effect of IT/business collaboration is stronger than the mediating effect.

5.2 Managerial Implications

The results of the papers belonging to this thesis also reveal several managerial implications for the three research directions:

Adoption: Why and under what circumstances do organizations introduce SOA? When an organization decides to adopt SOA the following critical organizational safeguards should be assessed before SOA is rolled out (**Paper II**): educating IT employees to have the necessary IT expertise for implementing SOA and convincing top management, which in turn should support the SOA initiative. Moreover, the compatibility of SOA with the existing organizational IT setting of the firm's business processes should also be assessed for a successful SOA adoption. Otherwise, the degree of SOA adoption will remain on a comparably low level and SOA will not be woven sufficiently into the organization to deliver its value.

Business impact: What are the benefits resulting from SOA? This thesis shows IT managers what they can expect from a holistic SOA implementation and also the extent to which business benefits are achievable when service-oriented principles are limited to some of the enterprise architecture layers (**Paper III**). Also, the results show that practitioners implementing SOA holistically increase business process quality (**Paper V**). The analyses further reveal that architecture modularity should be taken more into account as an outsourcing readiness component, since it affects related decision determinants: sourcing benefits, risks, and flexibility (**Paper VI**). Thus, investment decisions regarding whether to adopt SOA and where to start to achieve quick returns can be made on more solid ground. Moreover, the results show that some benefits are achievable only to a limited degree by resource picking in terms of implementing SOA, but can be increased by IT flexibility as a dynamic capability and that reuse is not an imperative to achieve the desired business benefits and make SOA valuable.

Furthermore, the results offer new insights into SOA's business value, such as diminishing marginal utility of increasing SOA maturity that could assist managers in their decision regarding the optimal SOA maturity for their particular organization (**Paper IV**). Moreover, managers can apply the developed and tested instrument for SOA maturity consisting of 21 items to assess their organization's overall SOA maturity, but also the maturity of each of the OSIMM's seven subdimensions. Such a self-analysis allows firms to identify subdimensions that are less mature than others and consequently need special management attention. Also, organizations can use the developed instruments to benchmark their SOA maturity (and the related outcomes) with other firms.

Governance: How should SOA introduction and management be governed to achieve the benefits? For managers, the results are helpful in implementing and developing service-oriented architectures. Organizations striving for higher IT flexibility or reuse as a substantial goal of an SOA initiative can use the results to single out promising SOA governance mechanisms (**Paper VII**). Notably, establishing new SOA decision-making bodies, such as the often called for SOA centers of excellence, hampers modularity, integration and reuse in the beginning. Thus, one important managerial result is that organizations do not necessarily need to implement new decision-making bodies but should prefer adapting existing ones. Among others, standards, employee qualification, and IT/business communication are important for these purposes. Managers pursuing better IT scalability are also well advised to follow this recommendation, as these three mechanisms (but only these of the investigated) also drive scalability. For improving modularity, clear service development processes and the collaborative work of business units are applicable governance mechanisms. Further, the findings suggest that managers should not hope for better alignment automatically following the SOA implementation, but instead explicitly implement management actions that facilitate collaboration between business and IT as this further improves the outcomes of implementing SOA (**Paper VIII**). Typical examples for creating a mutual understanding and improving IT/business collaboration are job rotations, joint workshops and trainings, informal meetings, etc.

6 Limitations

When interpreting the results of this cumulative dissertation thesis, a number of limitations have to be considered according to the applied methodologies:

The literature review only covers the years 2000 to 2009 (**Paper I**). Of course, additional articles were published in the meantime. Also, this review only concentrated on a selection of top journals, four conferences, and three books, without using backward and forward searches in other outlets (Levy and Ellis 2006). However, the identified articles were primarily used to identify the research questions and to develop the research directions. Additional articles published after 2009 or in other outlets have been reviewed for the detailed research model development in the other seven papers.

The remaining papers follow an empirical research approach and thus all share some limitations due to the joint data collection and analysis methods (**Paper II** to **Paper VIII**):

First, like most survey-based studies, our research may be subject to single-respondent bias. Exclusively surveying the opinion of leading IT architects or IT executives, who assumedly have the best information regarding the status of the SOA implementation and the general IT architecture of their organizations, may impact our results. For example, this could lead to a rather technical perspective on the adoption of SOA, which potentially underestimates the influence of factors associated with the environmental context (**Paper II**), the responses regarding the business benefits may be positively biased (**Paper III** and **Paper IV**), the informant might not have a detailed overview regarding the non-IT related aspects of BPM or the role of SOE in the organization (**Paper V**), might not have a complete picture when judging the BPO related items (**Paper VI**), or might not give completely unbiased answers regarding the collaboration between IT and business (**Paper VIII**). However, the tests for common method bias did not reveal a major problem in our data and thus we do not expect this to substantially affect the covariances in our research models.

Second, we have surveyed only organizations operating in one country (Germany) and in one industry (service), which moreover were sampled from the 3,000 largest organizations in that sector. This limits the generalizability of our results to this population (Lee and Baskerville 2003; Seddon and Scheepers 2012). However, this restriction also allows for a more robust interpretation of the results, as they are not influenced by contingency factors residing on the country or industry level.

Third, the adoption of SOA as well as SOA maturity was still limited in the investigated organizations, which might affect the results in such a way that the found evidence might be interpreted rather as lower boundary for the actual business impact of SOA. Also, the assessment of SOA's business impact relies only on qualitative measures (using Likert scales as common in SEM) and does not include a detailed examination of the costs and risks associated with adopting SOA. The low response rates to those questionnaire items asking for quantitative values, such as costs of SOA projects in percent of total IT budget, showed that those are hardly achievable. Thus we do not have quantitative values to estimate SOA's business impact in percent or on a monetary base, which would also be more difficult to compare across organizations of different sizes and varying SOA implementations.

Lastly, using surveys prevents detailed causal interpretation of single results and combinations of factors, as can be done in case studies. However, despite such potential limitations, we believe that our approach of conducting case studies prior to the survey and integrating these findings in the model development as well as the discussion of the results delivers valuable and valid insights into research on SOA from a business perspective, and represents a complementary contribution to the research works solely based on case studies that have already been published.

7 Future Research

The findings of this cumulative dissertation thesis contribute to research on SOA from a business perspective. Based on this, future research may use these results and provide additional insights. In particular, the following research perspectives will be important and exciting fields to be examined, and I advise future researchers to tap into these directions in order to further develop our understanding about how service orientation can be effectively implemented and exploited from an organizational perspective.

Comparing the importance of determinants at different stages of the SOA adoption process: In **Paper II** the impact of different adoption determinants on actual SOA adoption is investigated. The developed measurement instruments for the determinants could be used as starting point, to distinguish the importance of different TOE determinants at different stages of implementing SOA (e.g., initiation of implementing SOA vs. actual degree of adoption/implementation). First results, based on our empirical data show that relative advantage, costs, top management support and management fad are more significant and important for SOA initiation than for the actual adoption. At the same time, IT expertise is less significant while compatibility and organization size are not significant, at all, and thus do not drive the decision to adopt SOA. Thus, one could separate the roles of the TOE determinants as drivers of SOA initiation versus enablers of the actual organizational SOA implementation. This would increase the explanatory power of the model with respect to the different aspects of the adoption process. In this way, more practical guidelines for managers regarding important drivers and inhibitors of SOA adoption could be derived. This would support managers in their SOA evaluation and implementation process so they do not overlook critical factors in the beginning that will be important in later phases of the implementation process.

Assessing costs and risks associated with implementing SOA: While this study focused on the business impact of SOA in terms of benefits, future research should also explore the negative side of implementing SOA, which often is related with high costs and structural risks from fundamental changes (Choi et al. 2010). Such research could further help to evaluate the benefits achievable by adopting SOA with respect to the costs and risks an organization has to take for them. Such research would extend the business value assessment of **Paper III** and could also serve as a foundation for determining the optimal level of SOA maturity for an organization. The decreasing function of SOA benefits identified in **Paper IV** could be linked to functions of costs and risks associated with varying degrees of SOA maturity. The resulting decision model could support managers in determining the ideal level of SOA maturity. Moreover, certain maturity levels might be identified as being difficult to realize, e.g. many organizations are quickly moving towards maturity level 4, but higher levels are far from being reached. Such an observation could help answer the question whether firms (a) are satisfied with the achieved maturity level because the benefits achievable with higher maturity levels would not outweigh the related costs (e.g., for educating and training IT staff, implementing technical infrastructure, or adapting organizational and decision-making structures) and risks (e.g., performance risks or implementation risks), or (b) do they try to achieve a higher degree of maturity, but are unable to establish it.

Identifying how decision-making bodies and governance mechanisms can be implemented: In the latter case identified in the previous paragraph where organizations find barriers for reaching higher SOA maturity levels, future research needs to shed more light on SOA governance to identify those issues that hamper the achievement of higher levels of overall SOA maturity, or specific mechanisms for particular maturity dimensions. Is this, for instance, only a matter of available capital, or are other factors missing that are necessary for establishing a more mature SOA, such as clearly defined processes for service management, clear directions for using standards, or IT/business alignment? As, in particular, implementing new decision-making bodies for SOA turned out to be less helpful (in the beginning) than we had expected (**Paper VII**), future research should investigate different ways of implementing and adapting decision-making structures in organizations. Such analyses should scrutinize different scopes and degrees of power or rights associated with these decision-making bodies to reveal why which structures are useful for which purposes and which tradeoffs may arise.

Investigating and improving methods for transforming organizations to become SOEs: Future research should also investigate a more comprehensive set of BPM technologies and methods as well as SOE and its methods to advance the findings of **Paper V**. As our results have shown, only a limited number of organizations have so far adopted SOA holistically, i.e., also adopting the service paradigm on the business activity level. More research is needed that investigates methods for organizations that are traditionally structured along business departments that allows them to transform their organization into an SOE with shared service centers (Janssen and Joha 2008).

Methods suggested are business capability maps (König et al. 2005) or IBM's component business model (Ernest and Nisavic 2007) that could support organizations in developing new structures based on shared service centers. Adopting SOA is also expected to support the standardization of business processes (Beimborn et al. 2009), which consequently helps establishing shared service centers. However, for business process standardization and governing shared service centers, traditional approaches to business process management (BPM) have to be altered to achieve the expected benefits. Thus, new approaches to BPM and ways to achieve the associated tasks need to be investigated in the future. Closely associated with this enterprise planning perspective is the need for an extended alignment perspective that harmonizes services at the technical and business level. This is critical for many different aspects, such as reaching a higher degree of SOA adoption, achieving more benefits from SOA, as well as being able to easier outsource business processes.

Adopting the perspective of an insourcer and investigating how SOA affects their decision: Paper VI solely focused on the perspective how SOA impacts the benefits, risks, and sourcing flexibility for an organization that adopts SOA in the context of BPO. Future research, should also investigate the perspective of organizations that adopt SOA and how this might affect their ability or willingness to become an insourcer and act as service provider for other organizations. This possibility is supported by some of our case studies. SOA implementations will have advanced enough in the meantime to investigate the perspective of the insourcer instead of the outsourcer and how SOA affects the decision and the outcomes as well as identifying which other aspects (e.g., similar degree of service granularity and alignment between services and business functions) are important success factors. The emergence of platform-centric ecosystems can help to bring organizations together (Tiwana et al. 2010) to advance the cocreation of value (Ceccagnoli et al. 2012; Grover and Kohli 2012) and thereby be a good means to increase BPO in terms of Business-as-a-Service (Beimborn et al. 2011).

Overall, this dissertation thesis tries to advance our understanding of SOA from a business perspective: its characteristics, adoption determinants, governance mechanisms, and business impact. However, the sum of proposed areas for future research shows that investigating SOA from a business perspective is still a relatively unexplored field. Thus, I hope that scholars will continue to investigate SOA from a business perspective and shed even more light onto this phenomenon and to enable organizations to become more competitive in the future.

8 References

Abrahamson, E. 1991. "Managerial fads and fashions: The diffusion and rejection of innovations", *Academy of Management Review* (16:3), pp. 586–612.

Abrahamson, E. 1996. "Management fashion", *Academy of Management Review* (21:1), pp. 254–285.

Abramovsky, L. and Griffith, R. 2006. "Outsourcing and offshoring of business services: How important is ICT?", *Journal of the European Economic Association* (4:2/3), pp. 594–601.

Abramowicz, W. and Eymann, T. 2008. "Serviceorientierte Architekturen und Webservices", *Wirtschaftsinformatik* (50:1), pp. 1–3.

Aier, S., Bucher, T., and Winter, R. 2011. "Critical success factors of service orientation in information systems engineering", *Business & Information Systems Engineering* (3:2), pp. 77–88.

Aier, S., Riege, C., and Winter, R. 2008. "Unternehmensarchitektur – Literaturüberblick und Stand der Praxis", *Wirtschaftsinformatik* (50:4), pp. 292–304.

Alt, R., Abramowicz, W., and Demirkan, H. 2010. "Service-orientation in electronic markets", *Electronic Markets* (20:3), pp. 177–180.

Anand, N. and Daft, R.L. 2007. "What is the right organization design?", *Organizational Dynamics* (36:4), pp. 329–344.

Antikainen, J. and Pekkola, S. 2009. "Factors influencing the alignment of SOA development with business objectives", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Armstrong, J.S. and Overton, T.S. 1977. "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research* (14:3), pp. 396–402.

Arsanjani, A., Ghosh, S., Allam, A., Abdollah, T., Ganapathy, S., and Holley, K. 2008. "SOMA: A method for developing service-oriented solutions", *IBM Systems Journal* (47:3), pp. 377–396.

Arsanjani, A. and Holley, K. 2005. "Increase flexibility with the service integration maturity model (SIMM): Maturity, adoption, and transformation to SOA". retrieved 04/30/2010, from http://www.ibm.com/developerworks/webservices/library/ws-soa-simm/.

Aubert, B.A., Dussault, S., Rivard, S., and Patry, M. 1999. "Managing the risk of IT outsourcing", *Proceedings of the 32nd Hawaii International Conference on System Sciences (HICSS),* Wailea, Maui, HI, USA.

Aubert, B.A., Patry, M., and Rivard, S. 1998. "Assessing the risk of IT outsourcing", *Proceedings of the 31st Hawaii International Conference on System Sciences (HICSS),* Honolulu, Oahu, HI, USA.

Backhaus, K., Erichson, B., Plinke, W., and Weiber, R. 2008. *Multivariate Analysemethoden: Eine anwendungsorientierte Einführung*, (12 ed.). Berlin: Springer.

Bagozzi, R.P. 2011. "Measurement and meaning in information systems and organizational research: Methodological and philosophical foundations", *MIS Quarterly* (35:2), pp. 261–292.

Bahli, B. and Rivard, S. 2004. "Validating measures of information technology outsourcing risk factors", *Omega* (33:2), pp. 175-187.

Bajwa, I.S., Samad, A., Mumtaz, S., Kazmi, R., and Choudhary, A. 2009. "BPM meeting with SOA: A customized solution for small business enterprises", in: *2009 International Conference on Information Management and Engineering*. Los Alamitos, CA, USA: IEEE Computer Society, pp. 677–682.

Baldwin, C.Y. and Clark, K.B. 2000. *Design rules: The power of modularity*. Cambridge, MA: MIT Press.

Bardhan, I.R., Demirkan, H., Kannan, P.K., and Kauffman, R.J. 2010. "Special issue: Information systems in services", *Journal of Management Information Systems* (26:4), pp. 5–12.

Barney, J.B. 1991. "Firm resources and sustained competitive advantage", *Journal of Management* (17:1), pp. 99–120.

Baron, R.M. and Kenney, D.A. 1986. "The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology* (51:6), pp. 1173–1182.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Basu, A. and Blanning, R.W. 2003. "Synthesis and decomposition of processes in organizations", *Information Systems Research* (14:4), pp. 337–355.

Becker, A., Buxmann, P., and Widjaja, T. 2009. "Value potential and challenges of service-oriented architectures - a user and vendor perspective", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Becker, A., Widjaja, T., and Buxmann, P. 2011. "Value potentials and challenges of service-oriented architectures", *Business & Information Systems Engineering* (3:4), pp. 199–210.

Beimborn, D. 2008. *Cooperative sourcing - simulation studies and empirical data on outsourcing coalitions in the banking industry*. Wiesbaden: Gabler.

Beimborn, D., Joachim, N., and Münstermann, B. 2009. "Impact of service-oriented architectures (SOA) on business process standardization - proposing a research model", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Beimborn, D., Mädche, A., and Müller, B. 2011. "The role of platforms for enterprise ecosystems", in: *Workshop editorial, 41. Jahrestagung der Gesellschaft für Informatik*. Berlin, Germany.

Bernhard, R. and Jahn, B.U. 2009. "Modellgetriebene Entwicklung von serviceortientierten Architekturen", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 89–98.

Bharadwaj, A.S. 2000. "A resource-based perspective on information technology capability and firm performance: An empirical investigation", *MIS Quarterly* (24:1), pp. 169–196.

Bieberstein, N., Bose, S., Fiammante, M., Jones, K., and Shah, R. 2005a. *Service-oriented architecture (SOA) compass: Business value, planning, and enterprise roadmap*. Upper Saddle River, NJ: IBM Press.

Bieberstein, N., Bose, S., Walker, L., and Lynch, A. 2005b. "Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals", *IBM Systems Journal* (44:4), pp. 691–708.

Bollen, K.A. 2011. "Evaluating effect, composite, and causal indicators in structural equation models", *MIS Quarterly* (35:2), pp. 359–372.

Brahe, S. 2007. "BPM on top of SOA: Experiences from the financial industry", in: *Business process management,* P.D.G. Alonso and M. Rosemann (eds.). Heidelberg: Springer, pp. 96–111.

Brown, G. and Carpenter, R. 2004. "Successful application of service-oriented architecture across the enterprise and beyond", *Intel Technology Journal* (8:4), pp. 345–359.

Brown, R.H. and Karamouzis, F. 2001. "The services value chain: Forging the links of services and sourcing", *Gartner Research*.

Brown, W.A., Moore, G., and Tegan, W. 2006. "SOA governance - IBM's approach", IBM Corporation, Somers, NY.

Bühl, A. 2008. *SPSS 16: Einführung in die moderne Datenanalyse*, (11 ed.). München: Pearson Studium.

Byrd, T.A. and Turner, D.E. 2000. "Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct", *Journal of Management Information Systems* (17:1), pp. 167–208.

Ceccagnoli, M., Forman, C., Huang, P., and Wu, D.J. 2012. "Cocreation of value in a platform ecosystem: The case of enterprise software", *MIS Quarterly* (36:1), pp. 263–290.

Chanopas, A., Krairit, D., and Khang, D.B. 2006. "Managing information technology infrastructure: A new flexibility framework", *Management Research News* (29:10), pp. 632–651.

Chau, P.Y.K. and Tam, K.Y. 1997. "Factors affecting the adoption of open systems: An exploratory study", *MIS Quarterly* (21:1), pp. 1–24.

Cherbakov, L., Galambos, G., Harishankar, R., Kalyana, S., and Rackham, G. 2005. "Impact of service orientation at the business level", *IBM Systems Journal* (44:4), pp. 653–668.

Chin, W.W. 1998a. "Issues and opinion on structural equation modeling", *MIS Quarterly* (22:1), pp. vii–xvi.

Chin, W.W. 1998b. "The partial least square approach to structural equation modeling", in: *Modern methods for business research,* G.A. Marcoulides (ed.). Mahwah, NJ, USA: Lawrence Erlbaum Associates, pp. 295–336.

Chin, W.W., Marcolin, B.L., and Newsted, P.R. 2003. "A partial least squares latent variable modeling approach for measuring interaction effects: Results from a monte carlo simulation study and an electronic-mail emotion/adoption study", *Information Systems Research* (14:2), pp. 189–217.

Chin, W.W. and Newsted, P.R. 1999. "Structural equation modeling analysis with small samples using partial least squares", in: *Statistical strategies for small sample research,* R.H. Hoyle (ed.). Thousand Oaks: Sage Publications, Ltd., pp. 307–341.

Choi, J., Nazareth, D.L., and Jain, H.K. 2010. "Implementing service-oriented architecture in organizations", *Journal of Management Information Systems* (26:4), pp. 253–286.

Chung, S.H., Rainer, R.K., and Lewis, B.R. 2003. "The impact of information technology infrastructure flexibility on strategic alignment and applications implementation", *Communications of the Association for Information Systems* (11:1), pp. 191–206.

Ciganek, A.P., Haines, M.N., and Haseman, W.D. 2009. "Service-oriented architecture adoption: Key factors and approaches", *Journal of Information Technology Management* (XX:3), pp. 42–54.

Conger, S. 2010. "From the special issue editor: Servitizing IT", *Information Systems Management* (27:2), pp. 100–102.

Cooper, H. 1988. "Organizing knowledge syntheses: A taxonomy of literature reviews", *Knowledge, Technology & Policy* (1:1), pp. 104–126.

Cunningham, S.M. 1967. "The major dimensions of perceived risk", in: *The major dimensions of perceived risk, risk taking and information handling in consumer behaviour,* D.F. Cox (ed.). Boston (MA): Harvard University Press, pp. 82-108.

Davenport, T.H. 2005. "The coming commoditization of processes", *Harvard Business Review* (83:6), pp. 100-108.

Davis, F.D. 1989. "Perceived usefulness, perceived ease of use, and user acceptance of information technology", *MIS Quarterly* (13:3), pp. 319–340.

Demirkan, H. and Goul, M. 2006. "AMCIS 2006 panel summary: Towards the service oriented enterprise vision: Bridging industry and academics", *Communications of the Association for Information Systems* (18:1), pp. 546–556.

DePietro, R., Wiarda, E., and Fleischer, M. 1990. "The context for change: Organization, technology and environment", in: *The processes of technological innovation,* L.G. Tornatzky and M. Fleischer (eds.). Lexington, MA: Lexington Books, pp. 151–175.

Dubé, L. and Paré, G. 2003. "Rigor in information systems positivist case research: current practices, trends, and recommendations", *MIS Quarterly* (27:4), pp. 597–635.

Duncan, N.B. 1995. "Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measure", *Journal of Management Information Systems* (12:2), pp. 37–57.

Duncan, R. 1979. "What is the right organization structure? Decision tree analysis provides the answer", *Organizational Dynamics* (7:3), pp. 59–80.

Earl, M.J. 1996. "The risks of outsourcing IT", *Sloan Management Review* (37:3), pp. 26-32.

Eckert, J., Bachhuber, M., Repp, N., and Steinmetz, R. 2009. "The implementation of service-oriented architectures in the german banking industry - a case study", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–8.

Eisenhardt, K.M. 1989. "Building theories from case study research", *Academy of Management Review* (14:4), pp. 532–550.

Erickson, J. and Siau, K. 2008. "Web services, service-oriented computing, and service-oriented architecture: Separating hype from reality", *Journal of Database Management* (19:3), pp. 42–54.

Erl, T. 2005. *Service-oriented architecture: Concepts, technology, and design*. Upper Saddle River, NJ: Prentice Hall.

Ernest, M. and Nisavic, J.M. 2007. "Adding value to the IT organization with the component business model", *IBM Systems Journal* (46:3), pp. 387–403.

Ernst, R. and Kamrad, B. 2000. "Evaluation of supply chain structures through modularization and postponement", *European Journal of Operational Research* (124:3), pp. 495–510.

Ferstl, O.K. and Sinz, E.J. 1995. "Der Ansatz des Semantischen Objektmodells (SOM) zur Modellierung von Geschäftsprozessen", *Wirtschaftsinformatik* (37:3), pp. 209–220.

Ferstl, O.K. and Sinz, E.J. 1998. "SOM modeling of business systems", in: *Handbook on architectures of information systems,* P. Bernus, K. Mertins, and G. Schmidt (eds.). Berlin: Springer, pp. 339–358.

Fichman, R.G. 1992. "Information technology diffusion: A review of empirical research", in: *Proceedings of the 13th International Conference on Information Systems (ICIS)*. Dallas, TX, USA.

Fichman, R.G. 2004. "Going beyond the dominant paradigm for information technology innovation research: Emerging concepts and methods", *Journal of the Association for Information Systems* (5:8), pp. 314–355.

Fishbein, M. and Ajzen, I. 1975. *Belief, attitude, intention and behaviour: An introduction to theory and research*. Reading, Mass.: Addison-Wesley.

Gable, G.G. 1994. "Integrating case study and survey research methods: An example in information systems", *European Journal of Information Systems* (3:2), pp. 112–126.

Gefen, D., Rigdon, E.E., and Straub, D. 2011. "An update and extension to SEM guidelines for administrative and social science research", *MIS Quarterly* (35:2), pp. iii–A7.

Gewald, H. and Dibbern, J. 2009. "Risks and benefits of business process outsourcing: A study of transaction services in the german banking industry", *Information & Management* (46:4), pp. 249–257.

Gewald, H., Wüllenweber, K., and Weitzel, T. 2006. "The influence of perceived risks on banking managers' intention to outsource business processes - a study of the german banking and finance industry", *Journal of Electronic Commerce Research* (7:2), pp. 78-96.

Glaser, J.P., Halvorson, G.C., Ford, M., Heffner, R., and Kastor, J.A. 2007. "Too far ahead of the IT curve?", *Harvard Business Review* (85:7/8), pp. 29–39.

Grover, V. and Kohli, R. 2012. "Cocreating IT value: New capabilities and metrics for multifirm environments", *MIS Quarterly* (36:1), pp. 225–232.

Haes, S. and van Grembergen, W. 2009. "An exploratory study into IT governance implementations and its impact on business/IT alignment", *Information Systems Management* (26:2), pp. 123–137.

Hagel, J. and Brown, J.S. 2005. *The only sustainable edge: Why business strategy depends on productive friction and dynamic specialization*. Boston, Mass.: Harvard Business School Press.

Hayes, A. 2009. "Beyond Baron and Kenny: Statistical mediation analysis in the new millennium", *Communication Monographs* (76:4), pp. 408–420.

Heffner, R. 2010. "Insights for CIOs: SOA and beyond", *Forrester Research*.

Henseler, J. and Chin, W.W. 2010. "A comparison of approaches for the analysis of interaction effects between latent variables using partial least squares path modeling", *Structural Equation Modeling: A Multidisciplinary Journal* (17:1), pp. 82–109.

Hirschheim, R., Welke, R., and Schwarz, A. 2010. "Service-oriented architecture: Myths, realities, and a maturity model", *MIS Quarterly Executive* (9:1), pp. 37–48.

Ho, D.T.-Y., Jin, Y., and Dwivedi, R. 2009. "Business process management: A research overview and analysis", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA.

Hoetker, G. 2006. "Do modular products lead to modular organizations?", *Strategic Management Journal* (27:6), pp. 501-518.

Hung, R.Y.-Y. 2006. "Business process management as competitive advantage: A review and empirical study", *Total Quality Management* (17:1), pp. 21–40.

Janssen, M. and Joha, A. 2008. "Emerging shared service organizations and the service-oriented enterprise: Critical management issues", *Strategic Outsourcing: An International Journal* (1:1), pp. 35–49.

Jeyaraj, A., Rottman, J.W., and Lacity, M.C. 2006. "A review of the predictors, linkages, and biases in IT innovation adoption research", *Journal of Information Technology* (21:1), pp. 1–23.

Joachim, N. 2009. "Service-oriented architectures (SOA): An empirical investigation of adoption determinants and resulting business value", in: *Doctoral consortium of the 30th International Conference on Information Systems (ICIS)*. Phoenix, AZ, USA.

Joachim, N., Beimborn, D., Hoberg, P., and Schlosser, F. 2009. "Examining the organizational decision to adopt service-oriented architecture (SOA) – development of a research model", in: *Proceedings of the Special Interest Group on Adoption and Diffusion of Information Technology (DIGIT) (Pre-ICIS Workshop)*. Phoenix, AZ, USA.

Joachim, N., Beimborn, D., and Weitzel, T. 2010a. "Investigating adoption determinants of service-oriented architectures (SOA)", in: *Proceedings of the Special Interest Group on Services (SIG SVC) (Pre-ICIS Workshop)*. St. Louis, MO, USA.

Joachim, N., Beimborn, D., and Weitzel, T. 2010b. "Why do firms adopt service-oriented architectures? A conceptualization and evaluation of SOA adoption", in: *MIS Quarterly Prospective Authors (Pre-ICIS) Workshop*. St. Louis, MO, USA.

Joachim, N., Beimborn, D., and Weitzel, T. 2011a. "Eine empirische Untersuchung des Wertbeitrages von serviceorientierten Architekturen (SOA)", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Joachim, N., Beimborn, D., and Weitzel, T. 2011b. "An instrument for measuring SOA maturity", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*. Shanghai, China.

Joachim, N., Beimborn, D., and Weitzel, T. 2011c. "SOA-governance für effektive serviceorientierte Architekturen – Eine empirische Studie in der deutschen Dienstleistungswirtschaft", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Joachim, N., Beimborn, D., and Weitzel, T. 2011d. "What are important governance and management mechanisms to achieve IT flexibility in service-oriented architectures (SOA)?: An empirical exploration", in: *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS)*. Kauai, HI, USA: IEEE Computer Society, pp. 1–10.

Juran, J.M. 1986. "The quality trilogy: A universal approach to managing for quality", *Quality Progress* (9:8), pp. 19–24.

Keen, M., Acharya, A., Bishop, S., Hopkins, A., Milinski, S., Nott, C., Robinson, R., Adams, J., and Verschueren, P. 2004. *Patterns: Implementing an SOA using an enterprise service bus*. IBM Redbooks.

Kim, G.-m. and Kim, S.-Y. 2008. "Exploratory study on effective control structure in global business process sourcing", *Information Resource Management Journal* (21:3), pp. 101-118.

Klein, H.K. and Myers, M.D. 1999. "A set of principles for conducting and evaluating interpretive field studies in information systems", *MIS Quarterly* (23:1), pp. 67–93.

Kohnke, O., Scheffler, T., and Hock, C. 2008. "SOA-governance - an approach to management of service oriented architecture", *Wirtschaftsinformatik* (50:5), pp. 408–412.

König, W., Beimborn, D., Martin, S., and Homann, U. 2005. "Capability Map: Eine alternative Darstellungsweise für Unternehmensprozesse aus ressourcenorientierter Sicht", in: *Aspekte der Wirtschaftsinformatik,* J. Beyer and L. Mönch (eds.). San Diego: SCS-European Publishing House, pp. 1–20.

Krafzig, D., Banke, K., and Slama, D. 2005. *Enterprise SOA: Service-oriented architecture best practices*. Upper Saddle River, NJ: Prentice Hall.

Krammer, A., Heinrich, B., Henneberger, M., and Lautenbacher, F. 2011. "Granularity of services", *Business & Information Systems Engineering* (3:6).

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007a. "Does SOA improve the supply chain? An empirical analysis of the impact of SOA adoption on electronic supply chain performance", in: *Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society, pp. 1530–1605.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007b. "SOA and information sharing in supply chain: “How” information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Langlois, R.N. 2002. "Modularity in technology and organization", *Journal of Economic Behavior and Organization* (49:1), pp. 19-37.

Lee, A.S. 1989. "A scientific methodology for MIS case studies", *MIS Quarterly* (13:1), pp. 33–50.

Lee, A.S. and Baskerville, R.L. 2003. "Generalizing generalizability in information systems research", *Information Systems Research* (14:3), pp. 221–243.

Levy, Y. and Ellis, T.J. 2006. "A systems approach to conduct an effective literature review in support of information systems research", *Informing Science Journal* (9:1), pp. 181–212.

Liang, H., Saraf, N., Hu, Q., and Xue, Y. 2007. "Assimilation of enterprise systems: The effect of institutional pressures and the mediating role of top management", *MIS Quarterly* (31:1), pp. 59–87.

Lindell, M.K. and Whitney, D.J. 2001. "Accounting for common method variance in cross-sectional research designs", *Journal of Applied Psychology* (86:1), pp. 114–121.

Lowry, P.B., Romans, D., and Curtis, A. 2004. "Global journal prestige and supporting disciplines: A scientometric study of information systems journals", *Journal of the Association for Information Systems* (5:2), pp. 29–77.

Lublinsky, B. 2007. "Defining SOA as an architectural style: Align your business model with technology". retrieved 08/11/2010, from http://www.ibm.com/developerworks/architecture/library/ar-soastyle/.

Luthria, H. and Rabhi, F. 2009. "Service oriented computing in practice - an agenda for research into the factors influencing the organizational adoption of service oriented architectures", *Journal of Theoretical and Applied Electronic Commerce Research* (4:1), pp. 39–56.

Luthria, H., Rabhi, F., and Briers, M. 2007. "Investigating the potential of service oriented architectures to realize dynamic capabilities", in: *Proceedings of the 2nd IEEE Asia-Pacific Service Computing Conference (APSCC)*. Tsukuba, Japan, pp. 390–397.

Maglio, P.P., Spohrer, J., Seidman, D.I., and Ritsko, J.J. 2008. "Preface: Service science, management, and engineering", *IBM Systems Journal* (47:1), pp. 3–4.

Mahoney, J.T. and Pandian, R.J. 1992. "The resource-based view within the conversation of strategic management", *Strategic Management Journal* (13:5), pp. 363–380.

Makadok, R. 2001. "Toward a synthesis of the resource-based and dynamic-capability views of rent creation", *Strategic Management Journal* (22:5), pp. 387–401.

Malhotra, A., Gosain, S., and El Sawy, O.A. 2005. "Absorptive capacity configurations in supply chains: Gearing for partner-enabled market knowledge creation", *MIS Quarterly* (29:1), pp. 145–187.

Malinverno, P. 2006. "Service-oriented architecture craves governance". Gartner Group Research Note, G00135396.

Mani, D., Barua, A., and Whinston, A.B. 2006. "Successfully governing business process outsourcing relationships", *MIS Quarterly Executive* (5:1), pp. 15-29.

Martin, S., Beimborn, D., Parikh, M.A., and Weitzel, T. 2008. "Organizational readiness for business process outsourcing: A model of determinants and impact on outsourcing success", *Proceedings of the 41st Hawaii International Conference on System Sciences (HICSS),* Waikoloa, Big Island, HI, USA.

Mathiassen, L. and Sorensen, C. 2008. "Towards a theory of organizational information services", *Journal of Information Technology* (23:4), pp. 313–329.

Mathieu, J.E., Goodwin, G.F., Heffner, T.S., Salas, E., and Cannon-Bowers, J.A. 2000. "The influence of shared mental models on team process and performance", *Journal of Applied Psychology* (85:2), pp. 273–283.

Mathieu, J.E., Rapp, T.L., Maynard, M.T., and Mangos, P.M. 2010. "Interactive effects of team and task shared mental models as related to air traffic controllers' collective efficacy and effectiveness", *Human Performance* (23:1), pp. 22–40.

Melville, N., Kraemer, K.L., and Gurbaxani, V. 2004. "Review: Information technology and organizational performance: An integrative model of IT business value", *MIS Quarterly* (28:2), pp. 283-322.

Merrifield, R., Calhoun, J., and Stevens, D. 2008. "The next revolution in productivity", *Harvard Business Review* (86:6), pp. 72–80.

Meschke, M. and Baumoel, U. 2010. "Architecture concepts for value networks in the service industry", in: *Proceedings of the 31st International Conference on Information Systems (ICIS)*. St. Louis, MI, USA, pp. 1–13.

Mishra, A.N., Konana, P., and Barua, A. 2007. "Antecedents and consequences of internet use in procurement: An empirical investigation of U.S. manufacturing firms", *Information Systems Research* (18:1), pp. 103–120.

Mithas, S. and Whitaker, J. 2007. "Is the world flat or spiky? Information intensity, skills, and global service disaggregation", *Information Systems Research* (18:3), pp. 237–259.

Mohammed, S., Klimoski, R., and Rentsch, J.R. 2000. "The measurement of team mental models: We have no shared schema", *Organizational Research Methods* (3:2), pp. 123-166.

Momme, J., Moeller, M.M., and Hvolby, H.-H. 2000. "Linking modular product architecture to the strategic sourcing process: Case studies of two danish industrial enterprises", *International Journal of Logistics: Research & Applications* (3:2), pp. 127–146.

Mueller, B., Viering, G., Legner, C., and Riempp, G. 2010. "Understanding the economic potential of service-oriented architecture", *Journal of Management Information Systems* (26:4), pp. 145–180.

Oey, K.J. 2007. *Softwarearchitektur heute: Nutzen und Kosten serviceorientierter Architekturen*. Saarbrücken: VDM Verl. Dr. Müller.

Oh, L.-B., Leong, Y.-X., Teo, H.-H., and Ravichandran, T. 2007. "Service-oriented architecture and organizational integration: An empirical study of IT-enabled sustained competitive advantage", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Pagel, P. 2009. "SOA? SOA!", *Wirtschaftsinformatik & Management* (1:2), p. 3.

Papazoglou, M.P. and Heuvel, W.-J. 2007. "Service oriented architectures: Approaches, technologies and research issues", *The VLDB Journal* (16:3), pp. 389–415.

Papazoglou, M.P., Traverso, P., Dustdar, S., and Leymann, F. 2008. "Service-oriented computing: A research roadmap", *International Journal of Cooperative Information Systems* (17:2), pp. 223–255.

Patton, M.Q. 2002. *Qualitative research & evaluation methods*, (3 ed.). Thousand Oaks: Sage.

Penrose, E.T. 1959. *The theory of the growth of the firm*. Oxford, UK: Oxford University Press.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. 2003. "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Psychology* (88:5), pp. 879–903.

Polites, G.L., Roberts, N., and Thatcher, J. 2012. "Conceptualizing models using multidimensional constructs: A review and guidelines for their use", *European Journal of Information Systems* (21:1), pp. 22–48.

Powell, T.C. 1995. "Total quality management as competitive advantage: A review and empirical study", *Strategic Management Journal* (16:1), pp. 15–37.

Preacher, K.J. and Hayes, A.F. 2004. "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods* (36:4), pp. 717–731.

Purao, S., Khatri, V., and Cameron, B. 2011. "Guest editorial preface: Service-oriented architecture and computing", *Journal of Database Management* (22:2), pp. i–iv.

Rai, A., Tang, X.L., Brown, P., and Keil, M. 2006. "Assimilation patterns in the use of electronic procurement innovations: A cluster analysis", *Information & Management* (43:3), pp. 336–343.

Rathfelder, C. and Groenda, H. 2008. "iSOAMM: An independent SOA maturity model", in: *Distributed applications and interoperable systems*. Berlin, Heidelberg: Springer, pp. 1–15.

Ren, M. and Lyytinen, K.J. 2008. "Building enterprise architecture agility and sustenance with SOA", *Communications of the Association for Information Systems* (22:1), pp. 75–86.

Robey, D., Im, G., and Wareham, J.D. 2008. "Theoretical foundations of empirical research on interorganizational systems: Assessing past contributions and guiding future directions", *Journal of the Association for Information Systems* (9:9), pp. 497–518.

Rogers, E.M. 2003. *Diffusion of innovations*, (5. ed.). New York, NY: Free Press.

Sanchez, R. and Mahoney, J.T. 1996. "Modularity, flexibility, and knowledge management in product and organization design", *Strategic Management Journal* (17:Winter Special Issue), pp. 63–76.

Saran, C. 2006. "SOA will fail without governance warns gartner". retrieved 08/11/2010, from http://www.computerweekly.com/Articles/2006/09/07/218322/soa-will-fail-without-governance-warns-gartner.htm.

Schepers, T.G.J., Iacob, M.E., and van Eck, P.A.T. 2008. "A lifecycle approach to SOA governance", in: *Proceedings of the 2008 ACM symposium on Applied computing*. Fortaleza, Ceara, Brazil: ACM, pp. 1055–1061.

Schilling, M.A. 2000. "Toward a general modular systems theory and its application to interfirm product modularity", *Academy of Management Review* (25:2), pp. 312–334.

Schulte, R.W. 1996. ""Service oriented" architectures, part 2", *Gartner Research*.

Schulte, R.W. and Natis, Y.V. 1996. ""Service oriented" architectures, part 1", *Gartner Research*.

Seddon, P.B. and Scheepers, R. 2012. "Towards the improved treatment of generalization of knowledge claims in IS research: Drawing general conclusions from samples", *European Journal of Information Systems* (21:1), pp. 6–21.

Seidman, D. and Ritsko, J.J. 2008. "Preface: SOA: From modeling to implementation", *IBM Systems Journal* (47:3), pp. 355–356.

Shang, S. and Seddon, P.B. 2002. "Assessing and managing the benefits of enterprise systems: The business manager's perspective", *Information Systems Journal* (12:4), pp. 271–299.

Sharma, S. 2008. *Applied multivariate techniques*, (15 ed.). New York, NY: Wiley.

Sholler, D. and Schulte, W. 2009. "Survey update: The value of SOA", *Gartner Research*.

Shrout, P. and Bolger, N. 2002. "Mediation in experimental and nonexperimental studies: New procedures and recommendations", *Psychological Methods* (7:4), pp. 422–445.

Siedersleben, J. 2007. "SOA revisited: Component orientation in system landscapes", *Wirtschaftsinformatik* (49:Special Issue), pp. 110–117.

Simon, H.A. 1962. "The architecture of complexity: American philosophical society", *Proceedings of the American Philosophical Society* (106:6), pp. 467–482.

Smith, H.A. and McKeen, J.D. 2008. "Creating a process-centric organization at FCC: SOA from the top down", *MIS Quarterly Executive* (7:2), pp. 71–84.

Söderström, E. and Meier, F. 2007. "Combined SOA maturity model (CSOAMM): Towards a guide for SOA adoption", in: *Enterprise Interoperability II,* R.J. Gonçalves, J.P. Müller, K. Mertins, and M. Zelm (eds.). Springer, pp. 389–400.

Stake, R.E. 2006. *Multiple case study analysis*. New York: Guilford Press.

Straub, D., Boudreau, M.-C., and Gefen, D. 2004. "Validation guidelines for IS positivist research", *Communications of the Association for Information Systems* (13, pp. 380–427.

Tafti, A., Mithas, S., and Krishnan, M.S. 2008. "The effects of information technology and service-oriented architectures on joint venture value", in: *Proceedings of the 29th International Conference on Information Systems (ICIS)*. Paris, France.

Takeishi, A. 2002. "Knowledge partitioning in the inter-firm division of labor: The case of automotive product development", *Organization Science* (13:3), pp. 321-338.

Tan, C. and Sia, S.K. 2006. "Managing flexibility in outsourcing", *Journal of the Association for Information Systems* (7:4), pp. 179-206.

Tan, S. 2009. "SOA adoption and benefit trends in tough times", *Gartner Research*.

Tanriverdi, H., Konana, P., and Ge, L. 2007. "The choice of sourcing mechanisms for business processes", *Information Systems Research* (18:3), pp. 280–299.

Teece, D.J., Pisano, G., and Shuen, A. 1997. "Dynamic capabilities and strategic management", *Strategic Management Journal* (18:7), pp. 509–533.

Tewary, A.K., Kosalge, P., and Motwani, J. 2009. "Piloting service oriented architecture—a case study in the oil industry", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–12.

The Open Group. 2009a. "The open group service integration maturity model (OSIMM)", Reading, Berkshire.

The Open Group. 2009b. *TOGAF version 9*, (9 ed.). Zaltbommel: Van Haren Publishing.

Thomas, M. and Weistroffer, H.R. 2007. "Aligning information systems development with service orientation: The service oriented systems model", in: *Proceedings of the 15th European Conference on Information Systems (ECIS)*. St. Gallen, Switzerland, pp. 1669–1680.

Thomas, O., Leyking, K., and Scheid, M. 2009. "Vorgehensmodelle zur Entwicklung serviceorientierter Softwaresysteme", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 181–190.

Tiwana, A. 2008. "Does technological modularity substitute for control? A study of alliance performance in software outsourcing", *Strategic Management Journal* (29:7), pp. 769-780.

Tiwana, A. and Konsynski, B. 2010. "Complementarities between organizational IT architecture and governance structure", *Information Systems Research* (21:2), pp. 288-304.

Tiwana, A., Konsynski, B., and Bush, A.A. 2010. "Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics", *Information Systems Research* (21:4), pp. 675–687.

Torraco, R.J. 2005. "Writing integrative literature reviews: Guidelines and examples", *Human Resource Development Review* (4:3), pp. 356–367.

Trkman, P., Kovačič, A., and Popovič, A. 2011. "SOA adoption phases", *Business & Information Systems Engineering* (3:4), pp. 211–220.

Uwizeyemungu, S. and Raymond, L. 2009. "Exploring an alternative method of evaluating the effects of ERP: A multiple case study", *Journal of Information Technology* (24:3), pp. 251–268.

Varadan, R., Channabasavaiah, K., Simpson, S., Holley, K., and Allam, A. 2008. "Increasing business flexibility and SOA adoption through effective SOA governance", *IBM Systems Journal* (47:3), pp. 473–488.

Venkatesh, V., Morris, M.G., Davis, G.B., and Davis, F.D. 2003. "User acceptance of information technology: Toward a unified view", *MIS Quarterly* (27:3), pp. 425–478.

Viering, G., Legner, C., and Ahlemann, F. 2009. "The (lacking) business perspective on SOA - critical themes in SOA research", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 45–54.

Vitharana, P., Bhaskaran, K., Jain, H., Wang, H.J., and Zhao, J.L. 2007. "Service-oriented enterprises and architectures: State of the art and research opportunities", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA.

vom Brocke, J., Simons, A., Niehaves, B., and Riemer, K. 2009a. "Reconstructing the giant: On the importance of rigour in documenting the literature search process", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy, pp. 789–801.

vom Brocke, J., Sonnenberg, C., and Simons, A. 2009b. "Value-oriented information systems design: The concept of potentials modeling and its application to service-oriented architectures", *Business & Information Systems Engineering* (1:3), pp. 223–233.

Walker, L. 2007. "IBM business transformation enabled by service-oriented architecture", *IBM Systems Journal* (46:4), pp. 651–667.

Webster, J. and Watson, R.T. 2002. "Analyzing the past to prepare for the future: Writing a literature review", *MIS Quarterly* (26:2), pp. xiii–xxiii.

Willcocks, L.P., Hindle, J., Feeny, D.F., and Lacity, M.C. 2004. "IT and business process outsourcing: The knowledge potential", *Information Systems Management* (21:4), pp. 7-15.

Windley, P.J. 2007. "Teaming up for SOA", *InfoWorld* (29:10), pp. 25–28.

Winkler, V. and Buhl, H.U. 2007. "Identification and design of services proceeding and exemplary use in the financial services sector", *Wirtschaftsinformatik* (49:4), pp. 257–266.

Winter, R. and Fischer, R. 2007. "Essential layers, artifacts, and dependencies of enterprise architecture", *Journal of Enterprise Architecture* (3:2), pp. 1–12.

Wolfe, R.A. 1994. "Organizational innovation: Review, critique and suggested research directions", *Journal of Management Studies* (31:3), pp. 405–431.

Woodley, T. and Gagnon, S. 2005. "BPM and SOA: Synergies and challenges", in: *Web information systems engineering,* A.H.H. Ngu, M. Kitsuregawa, E.J. Neuhold, J.-Y. Chung, and Q.Z. Sheng (eds.). Heidelberg: Springer, pp. 679–688.

Wüllenweber, K., Beimborn, D., Weitzel, T., and König, W. 2008. "The impact of process standardization on BPO success", *Information Systems Frontiers* (10:2), pp. 211-224.

Yin, R.K. 2003. *Case study research: Design and methods*, (3 ed.). Thousand Oaks: Sage Publications.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

Zairi, M. 1997. "Business process management: A boundaryless approach to modern competitiveness", *Business Process Management Journal* (3:1), pp. 64–80.

Zhao, J., Tanniru, M., and Zhang, L.-J. 2007. "Services computing as the foundation of enterprise agility: Overview of recent advances and introduction to the special issue", *Information Systems Frontiers* (9:1), pp. 1–8.

Zhao, J.L., Goul, M., Purao, S., Vitharana, P., and Wang, H.J. 2008. "Impact of service-centric computing on business and education", *Communications of the Association for Information Systems* (22:16), pp. 295–310.

Zhu, K. and Kraemer, K.L. 2005. "Post-adoption variations in usage and value of e-business by organizations: Cross-country evidence from the retail industry", *Information Systems Research* (16:1), pp. 61–84.

PAPER I

A LITERATURE REVIEW OF RESEARCH ON SERVICE-ORIENTED ARCHITECTURES (SOA): CHARACTERISTICS, ADOPTION DETERMINANTS, GOVERNANCE MECHANISMS, AND BUSINESS IMPACT

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Abstract

This literature review synthesizes existing research in the field of Service-Oriented Architectures (SOA) from a business perspective and integrates results from 40 works to offer researchers an overview about the existing body of knowledge in this research field as well as a research agenda, which unifies and extends previous efforts. While the literature regarding the technologies and design principles for SOA and even Service-Oriented Enterprises (SOE) converges, especially research regarding the identification of determinants influencing SOA adoption, governance mechanisms for effectively implementing SOA, and regarding SOA's actual business impact is needed. Previous empirical research indicated promising factors in each of these fields. However, future research should especially draw attention to cover each of the research areas holistically. Moreover, extending the use of empirical research methods will further improve our understanding regarding the importance of different adoption determinants, governance mechanisms, and the actual business value of SOA.

1 Introduction

In recent years, Service-Oriented Architectures (SOA) attract more and more the interest of both organizations as well as research (Viering et al. 2009). According to Forrester Research, 84% of the biggest global 2,000 enterprises "say they are using SOA now or will be by the end of 2010" (Heffner 2010). Initially, SOA research focused on technical aspects regarding the characteristics of SOA. However, after providing a solid technological base for implementing SOA, the business perspective on SOA gained increasing attention and research agendas as well as conceptual models for investigating SOA through the business' lens appeared (e.g., Beimborn et al. 2008; Demirkan and Goul 2006; Ren and Lyytinen 2008; Vitharana et al. 2007; Zhao et al. 2008). Also, first results regarding governance mechanisms for implementing SOA effectively or indicating SOA's business impact were shown by case studies (e.g., Baskerville et al. 2005; Hirschheim et al. 2010; Yoon and Carter 2007) or empirical evaluations of specific benefits, like SOA's impact on organizational integration (Oh et al. 2007), information sharing in supply chains (Kumar et al. 2007b), or the joint impact of SOA and business process management on process quality (Beimborn and Joachim 2011). Besides this, existing research also extended the focus from SOA to the broader concept of Service-Oriented Enterprises (SOE) (Bieberstein et al. 2005b; Brown and Carpenter 2004; Cherbakov et al. 2005; Janssen and Joha 2008; Vitharana et al. 2007), which "as an emerging architecture-of-business takes the view that service orientation helps to execute the business strategy of an enterprise with significant multi-dimensional benefits (flexibility to change, enhanced quality, effectiveness), in less time (time-to-value) and cost (efficiency) using IT" (Vitharana et al. 2007, p. 3).

Many researchers improved our understanding in the broad research field of SOA, including the emerging concept of SOE, determinants explaining the adoption of SOA and SOE, governance mechanisms for leveraging their potentials, as well as their possible impact on business value. However, as "in the majority of cases, literature reviews serve as *the* means to reveal open research gaps and are part of a larger research endeavor" (vom Brocke et al. 2009, p. 11), this paper conducts a review of the literature. Based on an analysis of 40 sources (17 journal articles, 20 conference papers, and three books) the literature review synthesizes existing research and integrates previous results in order to offer an overview about the existing body of knowledge as well as proposing a research agenda, which unifies and extends previous efforts.

The remainder of the paper is organized as follows: The next section explains the underlying methodology (i.e., literature review) and gives a detailed overview about the literature search process as well as existing related research. The third section presents the results of analyzing the identified literature regarding SOA with respect to four areas: characteristics, adoption determinants, governance mechanisms, and business impact. The fourth section discusses the results and develops a research agenda for future SOA research from a business perspective. Last, the work is summarized and its limitations are discussed as well as possibilities for extending this literature review on SOA are given.

2 Methodology and Overview

This literature review follows the framework for literature reviewing proposed by vom Brocke et al. (2009), which is based on a review of the review literature itself and especially highlights the need for comprehensibly documenting the process of literature search in a review article. The framework itself is structured into five phases, which are summarized as follows: (1) definition of review scope, (2) conceptualization of topic, (3) literature search, (4) literature analysis and synthesis, (5) research agenda.

(1) The *definition of the review scope* of this literature review is summarized in Figure 1 (categories applicable to this review on SOA research are highlighted), which is based on the taxonomy proposed by Cooper (1988) and adapted by vom Brocke et al. (2009). This literature review on hand *focuses* on <u>research outcomes</u> of research <u>applied in the domain of SOA</u>. The *goal* is to <u>integrate findings</u> with respect to four areas of SOA research, i.e., characteristics, adoption determinants, governance mechanisms, and business impact. The four areas of research are based on the only existing literature review on SOA from a business perspective, conducted by Viering et al. (2009), classifying 175 articles covering SOA and Web Services published between 2000 and 2009 with respect to their research topic. For example, for the first group (characteristics), they reveal that 18 articles deal with "artifacts and standards", 10 with "definitions", and 3 with "products". In contrast to this pure topic-based classification of research articles, the literature review on hand analyzes the research outcomes. For example, this analysis identifies similarities regarding which design principles constitute SOA, or which business benefits are achieved or not achieved in practice, instead of only reporting that 10 articles have investigated the benefits of SOA. Thus, instead of focusing on rather technical issues, such as particular implementation or orchestration details (Abraham et al. 2008; Louridas 2008) or investigating various methods for identifying services (Boerner and Goeken 2009; Klose et al. 2007), this literature review investigates SOA from a business perspective. As indicated before, this review draws on the framework for analyzing SOA research, developed by Viering et al. (2009). Thus, this paper on hand is *organized* along a <u>conceptual</u> structure. No particular *perspective* is taken in order to guarantee a <u>neutral representation</u> of the review results. The *audience* addressed by this review is <u>specialized scholars</u> interested in SOA or SOE. According to the taxonomy of literature reviews, the *coverage* can be classified as <u>representative,</u> as it is limited to samples of articles, which also stand for other articles, but does not explicitly consider the entirety of the literature.

<table>
<tr><th>Characteristics</th><th colspan="4">Categories</th></tr>
<tr><td>Focus</td><td>research outcomes</td><td>research methods</td><td>theories</td><td>applications</td></tr>
<tr><td>Goal</td><td>integration</td><td colspan="2">criticism</td><td>central issues</td></tr>
<tr><td>Organization</td><td>historical</td><td colspan="2">conceptual</td><td>methodological</td></tr>
<tr><td>Perspective</td><td colspan="2">neutral representation</td><td colspan="2">espousal of position</td></tr>
<tr><td>Audience</td><td>specialized scholars</td><td>general scholars</td><td>practitioners/politicians</td><td>general public</td></tr>
<tr><td>Coverage</td><td>exhaustive</td><td>exhaustive and selective</td><td>representative</td><td>central/pivotal</td></tr>
</table>

Figure 1. Taxonomy of this literature review on SOA (following Cooper 1988; and vom Brocke et al. 2009)

The second step is (2) *conceptualization of the topic*. It addresses the point that "the author of a review article must begin with a topic in need of review and a broad conception of what is known about the topic and potential areas where new knowledge may be needed" (Torraco 2005, p. 359). As indicated before, this review draws on the framework for analyzing SOA research, developed by Viering et al. (2009), and classifies SOA research with respect to the following areas: characteristics, adoption determinants, governance mechanisms, and business impact. (3) The *literature search* considered the sources presented in Table 1. These sources are selected based on the top 25 research journals according to the ranking developed by Lowry et al. (2004). In addition, the IBM Systems Journal which is listed as top global practitioner journal (Lowry et al. 2004) covering a significant part of SOA research was included. Also, four IS conferences (AMCIS, ECIS, HICSS, ICIS) are considered to cover more recent SOA research. Finally, also three widely cited SOA books (Erl 2005; Keen et al. 2004; Krafzig et al. 2005) are considered to give a more complete picture.

Table 1 lists the investigated journals and conferences, the name of the database used for searching, the respective fields, which were searched (if possible: title or abstract or keywords), and the coverage (at least 2000 to 2009). Last, the hits resulting from a query using the keywords "*SOA*" or "*service-oriented*" or *"service oriented"* for the particular journal or conference as well as the number of articles used for the following analysis and synthesis are listed. The decision whether a retrieved article (i.e., a hit) will be analyzed in detail in this literature review was made based on the title. If the title sounded relevant to the focus of this review, the abstract was screened to make a final decision. In total, 40 sources including journal and conference articles as well as the three books have been screened. However, as one can see, the main sources were IS conferences (20 articles analyzed), and the only journals out of the top 25 research journals as well as the one practitioner journal publishing relevant SOA articles are the *IBM Systems Journal* (8 articles), *Wirtschaftsinformatik* (6 articles), and *Communications of the ACM* (3 articles).

Journal	Database	Search fields	Coverage	Hits	Analyzed
MIS Quarterly	EBSCO Host - Business Source Premier	title | abstract | keywords	1977-2009	0	0
Information Systems Research			1990-2009	2	0
Journal of Management Information Systems			1984-2009	0	0
Management Science			1954-2009	4	0
Communications of the ACM			1965-2009	10	3
Decision Sciences			1970-2009	1	0
Information Systems Journal			1998-2009	0	0
Organization Science			1990-2009	0	0
Harvard Business Review			1922-2009	2	0
INFORMS Journal on Computing			1989-2009	0	0
Operations Research			1952-2009	0	0
Journal of Computer Information Systems			2000-2009	1	0
Decision Support Systems	ScienceDirect	all fields	2000-2009	32	0
Information and Organization			2000-2009	2	0
Information Systems			2000-2009	21	0
Information and Management			2000-2009	17	0
Journal of Strategic Information Systems			2000-2009	5	0
IEEE Transactions on Computers and Services Computing[1]	IEEE Computer Society	Exact Phrase	2000-2009	41	0
IEEE Transactions on Software Engineering[1]			2000-2009	47	0
IEEE Computer			2000-2009	55	0
ACM Transactions	ACM Digital Library	title | abstract	2000-2009	18	0
Journal of Information Systems	American Accounting Association (AAA) Digital Library	title | abstract | keywords	2000-2009	0	0
Wirtschaftsinformatik	SpringerLink and journal website	*not explained*	2000-2009	63[2]	6
IBM Systems Journal[3]	Journal Website	title | subject | abstract	2000-2008	35	8
European Journal of IS	Journal Website	full text	1991-2009	12	0
Journal of the Association for Information Systems	AIS Electonic Library (AISeL)	full text	2000-2009	4	0
International Conference on IS (ICIS)		title | abstract	1994-2009	5	3
Americas Conference on IS (AMCIS)		title | abstract	1997-2009	44	6
Hawaii International Conference on System Sciences (HICSS)	IEEE Xplore Digital Library	title | abstract	2000-2009	50	6
European Conference on IS (ECIS)	IS and Innovation Group of the LSE and Political Science	title	1993-2009	15	5

1 From the 13 IEEE Transactions journals only the three most suitable for SOA are investigated: computers, services computing, and software engineering

2 The 63 result from searching the period 2006-2009 using SpringerLink. 2000-2005 is not covered in SpringerLink. This period was investigated using the journal website leading to additional 64, 24, and 131 hits for service oriented, as searching for „service oriented" as phrase was not possible. Also, the results contain redundant hits.

3 The last issue of the IBM Systems Journal was published in 2008.

Table 1. Considered sources

The two last steps of the framework for literature reviewing (4) *literature analysis and synthesis* as well as developing a (5) *research agenda* are described in detail in sections 3 and 4 respectively, as these present the main contribution of the paper.

3 Results of the Literature Review

This section summarizes the research outcomes of the previous research (*literature analysis and synthesis)* with respect to the four areas of SOA research. While the area of the *characteristics of SOA* is mainly based on articles following conceptual or argumentative deductive research methods, the other three areas of SOA research (*adoption determinants, governance mechanisms, and business impact*) are primarily based on articles employing case studies or quantitative methods[13].

3.1 Characteristics of SOA

Table 2 presents the results of analyzing the articles covering SOA's characteristics. In total 38 of the 40 identified articles handle characteristics of SOA. Thus, this category has been very well researched. In the following, the findings are grouped into three subcategories. The first category consists of technologies used for implementing SOA. The second category presents common design principles applied in an service-oriented IS architecture. The last category shows principles used to establish an service-oriented enterprise (SOE) (Janssen and Joha 2008; Vitharana et al. 2007). While it is recognizable that previous research mainly described the first two subcategories, the principles associated with realizing an SOE architecture are quite often mentioned in the literature showing the close relationship of both concepts: SOA and SOE. Overall, the extracted intersection of aspects can be interpreted as a common understanding regarding the characteristics of SOA. As the identified characteristics are often found in conceptual research papers, it would be particularly interesting to analyze concrete SOA implementations of organizations to reveal which approach to SOA they follow.

[13] It would be possible to consider more articles using conceptual or argumentative deductive research methods for the latter three research fields as well, but this would only add propositions regarding possible factors or benefits. In order to enhance the understanding of the actual realizable benefits and actual governance mechanisms only articles using case studies or quantitative methods were included, which can provide answers and are not limited to plausible propositions.

Aspect	Example	Source
Technologies used for implementing an SOA		
Business process execution language (BPEL)	„Business process service: A service that orchestrates other services according to a business process. Implemented e.g. by using WS-BPEL.“ (Offermann and Bub 2009, p. 1)	1, 2, 4, 5, 6, 7, 8, 10, 14, 18, 26, 27, 30, 31, 36
Service registry/ repository	“Critical to the success of initiatives was the use of a UDDI registry. The registry facilitates service and component reuse by providing the architecture with the ability to look up services that exist and reuse them.” (Yoon and Carter 2007, p. 7)	2, 4, 6, 7, 8, 9, 11, 14, 15, 16, 19, 22, 23, 32, 34, 35
Enterprise service bus (ESB)	“At the core is an Enterprise Service Bus (ESB) supplying connectivity among services.” (Ferguson and Stockton 2005, p. 754)	4, 7, 10, 19, 26, 27, 32, 35, 37, 39
Web Services (XML, WSDL, SOAP)	“Service provider, who provides service functionality in the form of web services that are published by the Service Broker.” (Tewary et al. 2009, p. 8)	1, 2, 3, 6, 10, 14, 16, 34, 35, 39, 40
Design principles applied in an service-oriented IS architecture		
Modularity/ loose coupling	“The idea of SOA is to create a world of services being loosely coupled which can be flexibly combined to create dynamic business processes, new applications.” (Janssen 2008, p. 2)	1, 4, 5, 6, 8, 11, 13, 14, 16, 17, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 32, 33, 35, 37
Implementation independence	“Those independent services [...] can be accessed without any knowledge of their underlying implementation details.” (Vitharana et al. 2007, p. 6)	1, 4, 6, 7, 14, 19, 20, 27, 28, 29, 30, 32, 36, 37
(Open) standards	“Services represent abstract software elements and/or interfaces […] using widely applied standards.“ (Legner and Heutschi 2007, p. 1644)	3, 5, 6, 11, 14, 20, 21, 23, 25, 29, 35, 36, 37
Service description	“create services that are modular, accessible, well-described, implementation-independent, and interoperable” (Fremantle et al. 2002, p. 80)	1, 2, 3, 5, 6, 9, 10, 23, 32, 34, 37
Interoperability	“For all participants, enhancing interoperability between existing systems was a key aspect of the SOA effort.” (Haines and Haseman 2009, p. 7)	1, 4, 16, 24, 28, 30, 35, 36
Platform independence	“The interface is defined in a neutral manner that should be independent of the hardware platform, the operating system, and the programming language in which the service is implemented.” (Walker 2007, p. 651)	6, 11, 14, 19, 20, 28, 37
Service contract	“An SOA is a component model that interrelates the different functional units of an application, called ‘services,’ through well-defined interfaces and contracts between these services.” (Walker 2007, p. 651)	7, 8, 11, 19, 25
Principles used to establish an service-oriented enterprise		
Business process choreography	“Independent services with well-defined invokable interfaces which can be called in defined sequences to form business processes.” (Vitharana et al. 2007, p. 1)	1, 2, 5, 13, 24, 26, 27, 28, 29, 31, 32, 33, 35, 36, 39
Encapsulate business function	“Those services are clearly capsulated, and loosely coupled entities, which deliver a defined business functionality.” (Becker et al. 2009, p. 2087)	4, 7, 8, 11, 13, 14, 21, 24, 27, 28, 29, 30, 37
Align IT with business processes	“Service-orientation is not only about building IT systems using SOA but also encompasses the transformation of an enterprise through the alignment of business and IT to be efficient and effective.” (Vitharana et al. 2007, p. 3)	5, 14, 18, 27, 32
Decouple business from IT	“SOA must decouple business applications from technical services and make the enterprise independent of a specific technical implementation or infrastructure.” (Krafzig et al. 2005, p. 57)	7, 8, 30
Note: 1 Fremantle et al. (2002), 2 Papazoglou and Georgakopoulos (2003), 3 Tan et al. (2004), 4 Keen et al. (2004), 5 Cox and Kreger (2005), 6 Kano et al. (2005), 7 Krafzig et al. (2005), 8 Erl (2005), 9 Vetere and Lenzerini (2005), 10 Ferguson and Stockton (2005), 11 Baskerville et al. (2005), 12 Antikainen and Pekkola (2009), 13 Becker et al. (2009), 14 Eymann and Winter (2008), 15 Kumar et al. (2007b), 16 Oh et al. (2007), 17 Elfatatry (2007), 18 Pfeiffer and Winkelmann (2007), 19 Walker (2007), 20 Winkler and Buhl (2007), 21 Legner and Heutschi (2007), 22 Yoon and Carter (2007), 23 Kumar et al. (2007a), 24 Henningsson et al. (2007), 25 Müller et al. (2007), 26 Siedersleben (2007), 27 Vitharana et al. (2007), 28 Janssen (2008), 29 Hau et al. (2008), 30 Beverungen et al. (2008), 31 Lotz et al. (2008), 32 Arsanjani et al. (2008), 33 Eckert et al. (2009), 34 Tewary et al. (2009), 35 Haines and Haseman (2009), 36 Offermann and Bub (2009), 37 Luthria and Rabhi (2009), 38 Schelp and Aier (2009), 39 Bieberstein et al. (2005b), 40 Tafti et al. (2008)		

Table 2. Identified characteristics of SOA

3.2 Determinants Influencing SOA Adoption

Retrieving empirical articles regarding SOA adoption determinants shows sparse results. Only two papers explicitly investigate SOA adoption (Tewary et al. 2009; Yoon and Carter 2007) and a third paper mainly focuses on SOA maturity/ readiness and thereby offers some insights into factors actually influencing an organization's decision to adopt SOA (Eckert et al. 2009). In addition, Schelp and Aier (2009) do not investigate SOA adoption, but SOA's contribution to agility. Notably, they observed that the complexity, which is in many adoption models usually a negative determinant, increased in all of the five SOA case studies. Another interesting finding is that none of the papers on SOA adoption applies an underlying theory or framework for developing their SOA adoption model. Instead, e.g., Yoon and Carter (2007) analyzed different business vs. IT motivations in their cases and Tewary et al. (2009) applied a process view on how a single organization adopted SOA in three stages: assessment, evangelization, and pilot.

Aspect	Example	Finding	Source
Technology			
Compatibility	"This also means that OLM inherits a plethora of information systems from various time periods, developed on a variety of platforms." (Tewary et al. 2009, p. 3)	supported	22, 34
Relative advantage	"Along with standardization and automation SOA could now reduce operational costs, improve operational efficiency, and increase service reliability worldwide." (Tewary et al. 2009, p. 4)	supported	22, 34
Complexity	"Decoupling the systems has led to increased complexity, but the systems are more flexible and integration is easier now." (Schelp and Aier 2009, p. 6)	supported	34, 38
Costs	"The SOA adoption project involved four external consultants and eight resources from OLM for the period of nine months." (Tewary et al. 2009, p. 7)	supported	22, 34
Organization			
Organization size	"OLM Inc. is a multi-billion dollar company and one of the largest OEMs […] in the Oil industry." (Tewary et al. 2009, p. 3)	supported	34
Top management support	"The 'CEO strongly supported building end-to-end, service-oriented development and delivery platform,' said Wachovia's Susan Certoma." (Yoon and Carter 2007, p. 7)	supported	22
	"SOA is almost always driven by IT and receives only moderate management support." (Eckert et al. 2009, p. 7)	partly	33
IT experience	"These workshops addressed the IT staff as well as the business division staff. [...] They needed to get a look and feel of what it means to use SOA." (Tewary et al. 2009, p. 7)	supported	22, 34
Environment			
Management fashion	"The SOA adoption [...] is triggered by the bank and not by external consultants." (Eckert et al. 2009, p. 7)	not supported	33

Table 3. Identified determinants influencing SOA adoption

3.3 Governance Mechanisms for Implementing SOA

For investigating the field of SOA governance again primarily empirical articles have been found. However, very generic SOA governance frameworks, such as Niemann et al. (2008) or Kohnke et al. (2008), which develop an entire SOA governance framework based on the existing literature instead of evaluating single governance mechanisms in practice with respect to their relevance, are excluded[14]. In total, six papers on SOA governance mechanisms could be found. Notably, these works are less fragmented than the previous research on SOA adoption. For example, four of the articles comprehensively and consistently investigate nearly every aspect which could be identified in the body of literature (Bieberstein et al. 2005a; Tewary et al. 2009; Walker 2007; Yoon and Carter 2007). Thus, research in this area mainly investigates the eight aspects presented in the following figure. Service management thereby comprises sub-aspects such as the funding for SOA, which is seen as the most challenging task according to the results of expert interviews (Becker et al. 2009). However, as the existing literature does not explicitly use any of the existing SOA governance frameworks to structure its research regarding SOA governance, in this literature review the identified governance aspects are grouped into three areas following Kohnke et al. (2008): structures, processes, and employees.

Aspect	Example	Source
Structures		
Decision-making Body	„The internal SOA Center of Excellence (CoE) is represented as a virtual organization that consists of several internal organizations devoted to the advancement of SOA.” (Walker 2007, p. 652)	19, 22, 34, 39
Standards	“Internal service standards and SOA design criteria were published and enforced with existing enterprise architecture governance practices.” (Walker 2007, p. 660)	19, 34, 39
Processes		
Service management	“First, coordinate the integration of SOA into the enterprise by defining a set of enterprise policies and agreements for service ownership, funding, charging, and usage mandates and publishing SOA compliance criteria to promote a consistent SOA infusion into information and application designs.” (Walker 2007, p. 660)	13, 19, 22, 34, 39
Service development	“SOA enables reuse through the ‘build once and leverage’ approach (e.g., by using already existing functions instead of building new ones, thus eliminating redundant development and support costs).” (Walker 2007, p. 653)	13, 19, 22, 34
Employees		
Qualification	“Education programs and classroom sessions are critical to disseminating emerging concepts and bridging skill gaps.” (Bieberstein et al. 2005b, p. 694)	19, 22, 34, 39
Incentives	“Perhaps the biggest failure in most organizations that have attempted transformations is the lack of incentives for the desired behaviors. […]Although formal performance measures related to rewards serve as powerful incentives for reuse, there are others as well.” (Bieberstein et al. 2005b, p. 706)	19, 22, 39
Collaborative work of business units	“Some of the organizations purposely strengthened trust between business units. For example, Con-Way’s Maja Tibbling said that establishing trust between business units is very important.” (Yoon and Carter 2007, p. 7)	19, 22, 39
Business/IT alignment	“... because business and IT units must work together in designing, building, deploying, and operating services, to achieve a high level of alignment between business requirements and IT capabilities, which is required to create quality services.” (Yoon and Carter 2007, p. 8)	12, 22, 39

Table 4. Identified governance mechanisms for implementing SOA

3.4 SOA’s Business Impact

For assessing the business impact of adopting SOA, conceptual models such as Beimborn et al. (2008) are explicitly discarded, as they argument – based on other articles, such as empirical articles – why certain benefits should be achievable by SOA, but do not deliver findings whether this is the case in practice. Thus, SOA’s impact on an organization is only investigated by the results of empirical research in this literature review. Overall, 12 articles could be identified, which applied empirical methods in order to investigate the business value of SOA. From these 12 articles, just one used a mixed method approach (literature review and expert interviews, i.e., Becker et al.

[14] Otherwise, one could more or less add these two to every single aspect identified in this research field as further sources, which propose that these mechanisms are useful.

2009)[15], only 4 applied a quantitative research design (Kumar et al. 2007a; Kumar et al. 2007b; Oh et al. 2007; Tafti et al. 2008), while the remaining 7 articles investigated the business value of SOA using case studies. Only the results of the expert interviews (Becker et al. 2009) as well as two of the case study articles (Baskerville et al. 2005; Yoon and Carter 2007) reflect a quite complete view on the actual benefits achieved by adopting SOA in organizations. The other identified papers focus on particular types of benefits, for example, the impact of SOA in mergers and acquisitions (Henningsson et al. 2007) or the impact of SOA on joint venture value (Tafti et al. 2008). Similar to the SOA adoption determinants, this research field lacks an overarching categorization of the identified benefits, as well. Broadly, the different evaluated benefits can be distinguished into IT benefits and business benefits; Table 5 provides a more detailed sub-categorization.

Aspect	Example	Finding	Source
IT benefits			
Integration	"As shown by the study all respondents agreed to SOA making the integration easier than when using centralized system solutions" (Henningsson et al. 2007, p. 7)	supported	11, 16, 22, 24, 35, 37, 38
		partly	13
Reuse	"better reuse" (Becker et al. 2009, p. 6; Schelp and Aier 2009, p. 6; Yoon and Carter 2007, p. 5)	supported	13, 22
		partly	11, 37, 38
Scalability	"Tony Bishop, vice president and director of product management at Wachovia, pointed out that their IT needed to be flexible, adaptable, and scalable." (Yoon and Carter 2007, p. 4)	supported	22
Business benefits			
Business agility	"shorter time-to-market" (Becker et al. 2009, p. 6; Haines and Haseman 2009, pp. 5-6; Janssen 2008, p. 8; Schelp and Aier 2009, p. 6)	supported	11, 13, 22, 24, 28, 35, 37, 38
B2B integration	"We provide empirical evidence from recent data that service-oriented architecture can indeed enhance organizational integration." (Oh et al. 2007, p. 13)	supported	11, 13, 15, 16, 23, 24, 40
	"Our findings indicate that integrating partners using SOA could prove challenging because of the lack of industry standards and mature tool." (Luthria and Rabhi 2009, p. 6)	partly	37
Cost reduction	IT cost reduction in 8 of 8 cases (Haines and Haseman 2009, pp. 5-6)	supported	11, 22, 28, 35
		partly	13, 38
Data quality	"improved information quality and availability" (Becker et al. 2009, p. 6)	partly	13, 22, 35, 38
Business/IT alignment	"in some cases it appeared to have improved relationship with the business units" (Haines and Haseman 2009, p. 8)	supported	22
		partly	13, 24, 35
		not supported	11
Straight through processing (STP)	"One of the primary sources of strategic value for SOA is its role of enabling technology for application integration." (Baskerville et al. 2005, p. 4)	supported	11, 13, 24, 35
		partly	22
Process monitoring	"automation and management of processes" (Becker et al. 2009, p. 6)	partly	13, 35
Outsourcing	"simplified outsourcing" (Becker et al. 2009, p. 7)	supported	13

Table 5. Identified business impact of SOA

4 Discussion

This section presents the last step of the framework for literature reviewing (vom Brocke et al. 2009): developing a (5) *research agenda*. As Table 2 shows, a consensus regarding the characteristics of SOA in terms of technologies used for implementation, design principles applied in an

[15] Only the benefits identified in the expert interviews – and not the results of the literature review, which also includes conceptual papers, – have been used for assessing the actual business impact of SOA in this literature review.

service-oriented IS architecture, and also regarding design principles used for establishing an service-oriented enterprise (SOE) is achieved in the literature.

However, as the results also show, only very limited empirical research regarding the identification of adoption determinants, governance mechanisms, and the evaluation of SOA's actual business value has been conducted. As the proposed research agenda for future business-oriented research in the field of SOA shows (cf. Figure 2), a clear and concise understanding of SOA characteristics is crucial in order to investigate these three other areas, which depend on the concept of SOA. Thus, as a multidimensional measurement instrument comprising the three identified aspects of SOA has not been applied in the four existing quantitative studies, the research question (RQ1) "*How should SOA be conceptualized in empirical research?*" has to be answered first in order to use this measurement instrument for the remainder of the identified research questions in the other areas of SOA research from a business perspective. In addition, such a measurement instrument can be used to investigate different approaches to SOA implementation. For example, it could be revealed whether organizations concentrate on technologies, IS, business aspects, or which balance between these extreme approaches they apply when implementing SOA in their organization. Second, the SOA concept with its three main characteristics (cf. Table 2) is the main *dependent* variable in research investigating determinants influencing the adoption of SOA (cf. Table 3), which leads to research answering RQ2: *What are the factors influencing SOA adoption?*. This research could be grounded on the technology-organization-environment (TOE) framework (DePietro et al. 1990), which is often applied for investigating adoption at the organizational level (Chau and Tam 1997; Mishra et al. 2007; Zhu and Kraemer 2005). Thereby especially management fad and fashion as largely neglected potential determinants of adopting SOA should be investigated (Abrahamson 1991; Abrahamson 1996). Third, for investigating SOA's business impact (cf. Table 5) the concept of SOA is the main *independent* variable, where the identified IT and business benefits are the dependent variables dealing with research regarding RQ3: *What is the business value of SOA?*. Thereby, future research should investigate the holistic picture of achievable SOA benefits, which is extracted mainly from case studies, applying quantitative methods to justify and quantify the benefits on a broad empirical basis. Fourth, for further insights why in certain cases specific business benefits could be achieved or not (cf. Table 5), investigating governance mechanisms (cf. Table 4) could provide further insights regarding RQ4: *Which SOA governance mechanisms are important in order to implement an effective SOA?*. As previous research does not apply a common SOA governance framework to structure their findings, a suggestion for future research is the use of common governance frameworks, such as the one proposed by Kohnke et al. (2008), which suggests the following three categories of SOA governance mechanisms: structures, processes, and employees. This type of research needs to incorporate both the adoption of SOA in terms of its characteristics as well as aspects of its business impact since the effectiveness of governance mechanisms can only be judged with respect to its influence on IT and/or business benefits. The following figure visualizes the overall research agenda:

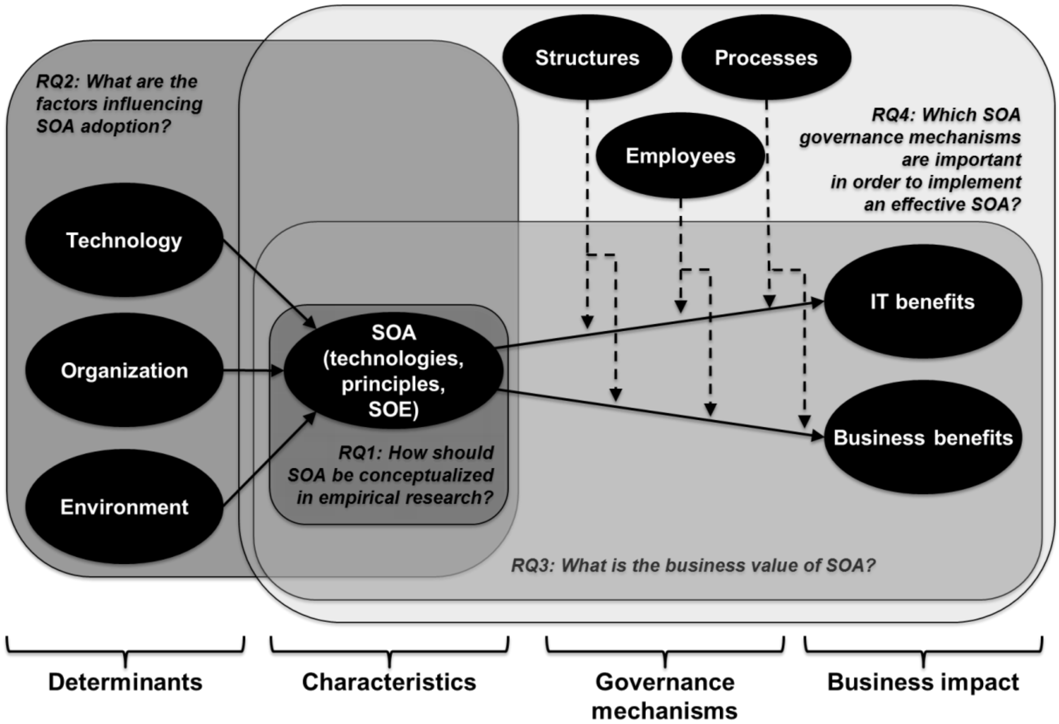

Figure 2. Proposed research agenda for future business-oriented research on SOA

Overall, the results show that the first articles applying empirical research methods enhanced the knowledge regarding which adoption determinants and governance mechanisms should be further investigated in order to understand the concept of SOA and its achievable business impacts by adopting SOA holistically. However, while in each of the four research fields only a very few case studies exist that aim at covering the field completely, most of previous research is fragmented. Particularly, quantitative studies are very seldom. Thus, future research should try to investigate each of the fields consistently and holistically, covering all of the identified aspects in a single research field as well as including the concept of SOA in an integrated way including both IT and business aspects. Thus, applying case studies and quantitative approaches to each of the SOA research fields allows comparing the relative importance of each of the aspects extracted from diverse articles.

5 Conclusion

This literature review synthesizes the existing research on SOA from a business perspective by analyzing 40 sources and integrates their results in order to offer an overview about the existing body of knowledge as well as proposing a research agenda, which unifies and extends previous efforts.

Previous research regarding SOA has moved on from a pure focus on technical aspects to business aspects surrounding SOA, which in particular leads to the emerging concept of the service-oriented enterprise (SOE) (Vitharana et al. 2007). While the literature regarding technologies and design principles for SOA and even SOE converges, especially the research fields regarding the identification of determinants influencing SOA adoption, governance mechanisms for effectively implementing SOA, and SOA's actual business impact, are in rather early and fragmented stages.

This literature review regarding SOA research faces some limitations itself. First, this literature review mainly covers the years 2000-2009. Of course, additional articles were published in the meantime, which should be included in a future version. Second, this review concentrated only on a selection of top journals, four conferences, and three books, without using backward and forward search (Levy and Ellis 2006). However, the identified articles, the detailed and transparent documentation of the literature search process, the proposed categorization of the aspects in each of the research fields, and the proposed research agenda can serve as a good starting point for further literature reviews and future research in the SOA research field.

6 References

Abraham, C., Junglas, I., and Willis, M. 2008. "Enabling an agile information supply chain in service oriented architectures with web services", in: *Proceedings of the 14th Americas Conference on Information Systems (AMCIS)*. Toronto, ON, Canada.

Abrahamson, E. 1991. "Managerial fads and fashions: The diffusion and rejection of innovations", *Academy of Management Review* (16:3), pp. 586–612.

Abrahamson, E. 1996. "Management fashion", *Academy of Management Review* (21:1), pp. 254–285.

Antikainen, J. and Pekkola, S. 2009. "Factors influencing the alignment of SOA development with business objectives", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Arsanjani, A., Ghosh, S., Allam, A., Abdollah, T., Ganapathy, S., and Holley, K. 2008. "SOMA: A method for developing service-oriented solutions", *IBM Systems Journal* (47:3), pp. 377–396.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Becker, A., Buxmann, P., and Widjaja, T. 2009. "Value potential and challenges of service-oriented architectures - a user and vendor perspective", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Beimborn, D. and Joachim, N. 2011. "The joint impact of service-oriented architectures and business process management on business process quality: An empirical evaluation and comparison", *Information Systems and e-Business Management* (9:3), pp. 333–362.

Beimborn, D., Joachim, N., and Weitzel, T. 2008. "Drivers and inhibitors of SOA business value – conceptualizing a research model", in: *Proceedings of the 14th Americas Conference on Information Systems (AMCIS)*. Toronto, ON, Canada.

Beverungen, D., Knackstedt, R., and Müller, O. 2008. "Developing service oriented architectures for product-service systems - a conceptual approach and its application for the recycling of electronic equipment", *Wirtschaftsinformatik* (50:3), pp. 220–234.

Bieberstein, N., Bose, S., Fiammante, M., Jones, K., and Shah, R. 2005a. *Service-oriented architecture (SOA) compass: Business value, planning, and enterprise roadmap*. Upper Saddle River, NJ: IBM Press.

Bieberstein, N., Bose, S., Walker, L., and Lynch, A. 2005b. "Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals", *IBM Systems Journal* (44:4), pp. 691–708.

Boerner, R. and Goeken, M. 2009. "Identification of business services literature review and lessons learned", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–9.

Brown, G. and Carpenter, R. 2004. "Successful application of service-oriented architecture across the enterprise and beyond", *Intel Technology Journal* (8:4), pp. 345–359.

Chau, P.Y.K. and Tam, K.Y. 1997. "Factors affecting the adoption of open systems: An exploratory study", *MIS Quarterly* (21:1), pp. 1–24.

Cherbakov, L., Galambos, G., Harishankar, R., Kalyana, S., and Rackham, G. 2005. "Impact of service orientation at the business level", *IBM Systems Journal* (44:4), pp. 653–668.

Cooper, H. 1988. "Organizing knowledge syntheses: A taxonomy of literature reviews", *Knowledge, Technology & Policy* (1:1), pp. 104–126.

Cox, D.E. and Kreger, H. 2005. "Management of the service-oriented-architecture life cycle", *IBM Systems Journal* (44:4), pp. 709–726.

Demirkan, H. and Goul, M. 2006. "AMCIS 2006 panel summary: Towards the service oriented enterprise vision: Bridging industry and academics", *Communications of the Association for Information Systems* (18:1), pp. 546–556.

DePietro, R., Wiarda, E., and Fleischer, M. 1990. "The context for change: Organization, technology and environment", in: *The processes of technological innovation,* L.G. Tornatzky and M. Fleischer (eds.). Lexington, MA: Lexington Books, pp. 151–175.

Eckert, J., Bachhuber, M., Repp, N., and Steinmetz, R. 2009. "The implementation of service-oriented architectures in the german banking industry - a case study", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–8.

Elfatatry, A. 2007. "Dealing with change: Components versus services", *Communications of the ACM* (50:8), pp. 35–39.

Erl, T. 2005. *Service-oriented architecture: Concepts, technology, and design*. Upper Saddle River, NJ: Prentice Hall.

Eymann, T. and Winter, R. 2008. "SOA – Ein neues Paradigma der Gestaltung verteilter Informationssysteme?", *Wirtschaftsinformatik* (50:1), pp. 70–76.

Ferguson, D.F. and Stockton, M.L. 2005. "Service-oriented architecture: Programming model and product architecture", *IBM Systems Journal* (44:4), pp. 753–780.

Fremantle, P., Weerawarana, S., and Khalaf, R. 2002. "Enterprise services", *Communications of the ACM* (45:10), pp. 77–82.

Haines, M.N. and Haseman, W.D. 2009. "Service-oriented architecture adoption patterns", in: *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA.

Hau, T., Ebert, N., Hochstein, A., and Brenner, W. 2008. "Where to start with SOA: Criteria for selecting SOA projects", in: *Proceedings of the 41st Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE.

Heffner, R. 2010. "Adoption of SOA: Still strong, even in hard times", *Forrester Research*.

Henningsson, S., Svensson, C., and Vallen, L. 2007. "Mastering the integration chaos following frequent M&As: IS integration with SOA technology", in: *Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society.

Hirschheim, R., Welke, R., and Schwarz, A. 2010. "Service-oriented architecture: Myths, realities, and a maturity model", *MIS Quarterly Executive* (9:1), pp. 37–48.

Janssen, M. 2008. "Exploring the service-oriented enterprise: Drawing lessons from a case study", in: *Proceedings of the 41st Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society.

Janssen, M. and Joha, A. 2008. "Emerging shared service organizations and the service-oriented enterprise: Critical management issues", *Strategic Outsourcing: An International Journal* (1:1), pp. 35–49.

Kano, M., Koide, A., Liu, T.K., and Ramachandran, B. 2005. "Analysis and simulation of business solutions in a service-oriented architecture", *IBM Systems Journal* (44:4), pp. 669–690.

Keen, M., Acharya, A., Bishop, S., Hopkins, A., Milinski, S., Nott, C., Robinson, R., Adams, J., and Verschueren, P. 2004. *Patterns: Implementing an SOA using an enterprise service bus*. IBM Redbooks.

Klose, K., Knackstedt, R., and Beverungen, D. 2007. "Identification of services - a stakeholder-based approach to SOA development and its application in the area of production planning", in: *Proceedings of the 15th European Conference on Information Systems (ECIS)*. St. Gallen, Switzerland, pp. 1802–1814.

Kohnke, O., Scheffler, T., and Hock, C. 2008. "SOA-governance - an approach to management of service oriented architecture", *Wirtschaftsinformatik* (50:5), pp. 408–412.

Krafzig, D., Banke, K., and Slama, D. 2005. *Enterprise SOA: Service-oriented architecture best practices*. Upper Saddle River, NJ: Prentice Hall.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007a. "Does SOA improve the supply chain? An empirical analysis of the impact of SOA adoption on electronic supply chain performance", in: *Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society, pp. 1530–1605.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007b. "SOA and information sharing in supply chain: “How” information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Legner, C. and Heutschi, R. 2007. "SOA adoption in practice - findings from early SOA implementations", in: *Proceedings of the 15th European Conference on Information Systems (ECIS)*. St. Gallen, Switzerland, pp. 1643–1654.

Levy, Y. and Ellis, T.J. 2006. "A systems approach to conduct an effective literature review in support of information systems research", *Informing Science Journal* (9:1), pp. 181–212.

Lotz, V., Pigout, E., Fischer, P.M., Kossmann, D., Massacci, F., and Pretschner, A. 2008. "Towards systematic achievement of compliance in service-oriented architectures: The master approach", *Wirtschaftsinformatik* (50:5), pp. 383–391.

Louridas, P. 2008. "Orchestrating web services with BPEL", *IEEE Software* (25:2), pp. 85–87.

Lowry, P.B., Romans, D., and Curtis, A. 2004. "Global journal prestige and supporting disciplines: A scientometric study of information systems journals", *Journal of the Association for Information Systems* (5:2), pp. 29–77.

Luthria, H. and Rabhi, F. 2009. "Using service oriented computing for competitive advantage", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–9.

Mishra, A.N., Konana, P., and Barua, A. 2007. "Antecedents and consequences of internet use in procurement: An empirical investigation of U.S. manufacturing firms", *Information Systems Research* (18:1), pp. 103–120.

Müller, B., Viering, G., Ahlemann, F., and Riempp, G. 2007. "Towards understanding the sources of the economic potential of service-oriented architecture: Findings from the automotive and banking industry", in: *Proceedings of the 15th European Conference on Information Systems (ECIS)*. St. Gallen, Switzerland.

Niemann, M., Eckert, J., Repp, N., and Steinmetz, R. 2008. "Towards a generic governance model for service-oriented architectures", in: *Proceedings of the 14th Americas Conference on Information Systems (AMCIS)*. Toronto, ON, Canada, pp. 1–10.

Offermann, P. and Bub, U. 2009. "A method for information systems development according to SOA", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–11.

Oh, L.-B., Leong, Y.-X., Teo, H.-H., and Ravichandran, T. 2007. "Service-oriented architecture and organizational integration: An empirical study of IT-enabled sustained competitive advantage", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Papazoglou, M.P. and Georgakopoulos, D. 2003. "Service-oriented computing", *Communications of the ACM* (46:10), pp. 25–28.

Pfeiffer, D. and Winkelmann, A. 2007. "Approaches to the re-use of software within the scope of software industrialisation taking the example of software components, service-orientated architectures and model-driven architectures", *Wirtschaftsinformatik* (49:3), pp. 208–216.

Ren, M. and Lyytinen, K.J. 2008. "Building enterprise architecture agility and sustenance with SOA", *Communications of the Association for Information Systems* (22:1), pp. 75–86.

Schelp, J. and Aier, S. 2009. "SOA and EA – sustainable contributions for increasing corporate agility", in: *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA.

Siedersleben, J. 2007. "SOA revisited: Component orientation in system landscapes", *Wirtschaftsinformatik* (49:Special Issue), pp. 110–117.

Tafti, A., Mithas, S., and Krishnan, M.S. 2008. "The effects of information technology and service-oriented architectures on joint venture value", in: *Proceedings of the 29th International Conference on Information Systems (ICIS)*. Paris, France.

Tan, Y.-S., Vellanki, V., Xing, J., Topol, G., and Dudley, G. 2004. "Service domains", *IBM Systems Journal* (43:4), pp. 734–755.

Tewary, A.K., Kosalge, P., and Motwani, J. 2009. "Piloting service oriented architecture—a case study in the oil industry", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–12.

Torraco, R.J. 2005. "Writing integrative literature reviews: Guidelines and examples", *Human Resource Development Review* (4:3), pp. 356–367.

Vetere, G. and Lenzerini, M. 2005. "Models for semantic interoperability in service-oriented architectures", *IBM Systems Journal* (44:4), pp. 887–903.

Viering, G., Legner, C., and Ahlemann, F. 2009. "The (lacking) business perspective on SOA - critical themes in SOA research", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 45–54.

Vitharana, P., Bhaskaran, K., Jain, H., Wang, H.J., and Zhao, J.L. 2007. "Service-oriented enterprises and architectures: State of the art and research opportunities", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA.

vom Brocke, J., Simons, A., Niehaves, B., and Riemer, K. 2009. "Reconstructing the giant: On the importance of rigour in documenting the literature search process", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy, pp. 789–801.

Walker, L. 2007. "IBM business transformation enabled by service-oriented architecture", *IBM Systems Journal* (46:4), pp. 651–667.

Winkler, V. and Buhl, H.U. 2007. "Identification and design of services proceeding and exemplary use in the financial services sector", *Wirtschaftsinformatik* (49:4), pp. 257–266.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

Zhao, J.L., Goul, M., Purao, S., Vitharana, P., and Wang, H.J. 2008. "Impact of service-centric computing on business and education", *Communications of the Association for Information Systems* (22:16), pp. 295–310.

Zhu, K. and Kraemer, K.L. 2005. "Post-adoption variations in usage and value of e-business by organizations: Cross-country evidence from the retail industry", *Information Systems Research* (16:1), pp. 61–84.

PAPER II

WHAT DRIVES SERVICE-ORIENTED ARCHITECTURE ADOPTION? TECHNOLOGICAL, ORGANIZATIONAL, AND ENVIRONMENTAL DRIVERS AND PATTERNS OF SOA ADOPTION

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Different parts of this research have been presented and discussed at three Pre-ICIS workshops (MISQ prospective authors workshop (Joachim et al. 2010b), Special Interest Group on Services (SIG SVC) workshop (Joachim et al. 2010a), and Special Interest Group on Adoption and Diffusion of Information Technology (DIGIT) (Joachim et al. 2009)) as well as at the doctoral consortium at ICIS (Joachim 2009)

Abstract

While the paradigm of service-oriented architecture (SOA) has conquered many domains of industry and academia, there remains neither an agreed-upon concept applicable in empirical research of what SOA actually is, how it can be measured, and which SOA adoption patterns exist, nor is there a comprehensive theory of *why* firms adopt SOA. Hence, we: (1) develop and test a theoretical model based on the technology-organization-environment (TOE) framework to explain why firms use SOA; (2) develop an SOA research construct and propose how to capture the degree of SOA adoption by a firm in empirical research from a holistic perspective; and (3) reveal different SOA adoption patterns. Based on a review of 38 studies that apply the TOE framework, we consider technological (relative advantage, compatibility, costs, and complexity), organizational (organization size, top management support, and IT expertise) and environmental (management fad, management fashion, and competition) adoption drivers and inhibitors to explain SOA adoption. We evaluate the model using data from 154 organizations. To our knowledge, this is the first comprehensive empirical study of the adoption of SOA, which moreover applies a unified multidimensional measurement of the degree of SOA adoption drawing on well-established enterprise architecture frameworks and covering technology, IS, and business architecture. The results reveal that organizations follow five different SOA adoption patterns.

1 Introduction

For some time, service-Oriented Architectures (SOAs) have received considerable attention in both business and academia (Viering et al. 2009). According to Forrester Research, 84 percent of the largest global 2,000 enterprises “say they are using SOA now or will be by the end of 2010” (Heffner 2010). The academic literature began to explore SOA by proposing research agendas or conceptualizing models (e.g., Demirkan and Goul 2006; Ren and Lyytinen 2008; Vitharana et al. 2007; Zhao et al. 2008); presenting results from case studies (e.g., Baskerville et al. 2005; Hirschheim et al. 2010); evaluating empirically specific SOA benefits such as organizational integration (Oh et al. 2007) or information sharing in supply chains (Kumar et al. 2007); and/or presenting solutions to improve SOA performance (Datta et al. 2011). However, while SOA is already on the Gartner’s hype cycle’s slope of enlightenment (Gartner 2009) becoming more mature and productive, we still have no theoretically coherent picture of why firms embrace the paradigm of service orientation. Most of the academic research focuses on technical aspects (i.e., how an SOA should be designed, implemented, and aligned with organization’s business functions); there remains a research gap on *why* firms adopt SOA.

Reviewing the academic literature (Joachim 2011) regarding research into SOA adoption and its determinants reveals only a very few empirical papers (i.e., that go beyond proposing conceptual models), all of which have applied a case study methodology (Ciganek et al. 2009; Eckert et al. 2009; Tewary et al. 2009; Yoon and Carter 2007). Thus, we were unable to find a single paper in the academic literature that examines the factors influencing an organization’s SOA adoption by applying a quantitative methodology to gain further insights on a broader empirical basis. Previous case studies have revealed a variety of different determinants such as technical decision drivers (e.g., lower IT costs or reducing redundancy), organizational drivers, or just management fashion (Abrahamson 1991); our goal is to develop a unifying SOA perspective that integrates these arguments by adapting the technology-organization-environment (TOE) framework (DePietro et al. 1990) to the SOA context. Hence we respond to the issue identified by Vitharana et al. that "future research should investigate organizational and industry characteristics that influence adoption of the service paradigm" (2007).

To address this issue, we evaluate those determinants of SOA adoption that potentially represent the rationale behind the adoption. In a second step, we investigate the degree to which organizations adopt or do not adopt SOA. As there are many interesting and different aspects associated with servitization, a first step to decide whether an organization is an adopter of SOA is to analyze the characteristics of SOA. This is necessary to make "SOA adoption" measurable and comparable, because not only are researchers just starting to develop empirical measures for SOA adoption but also the concrete conception of what SOA is varies from organization to organization. Finally, we identify different adoption patterns and how they are related to the SOA adoption determinants. Our guiding research questions hence are:

1) *What factors influence SOA adoption?*
2) *What distinct SOA adoption patterns can be observed? How does the impact of the factors differ among SOA adoption patterns?*

By answering these questions, our paper contributes to existing research by conceptualizing and empirically applying a unified and holistic multidimensional research construct for SOA adoption, developing and empirically evaluating an SOA adoption model, and identifying patterns of SOA adoption.

Next, we introduce SOA and develop a research model that proposes SOA adoption determinants using the TOE framework. In the third section, we present the methodology and data used to evaluate this research model and explain the development of a multidimensional instrument for measuring SOA adoption that unifies the existing perspectives on SOA. Subsequently, we discuss the results from testing the model with PLS and a cluster analysis.

2 Service-Oriented Architectures

The core aspect of SOA is the separation of the IT layer and the business processes layer by adding a new service layer, which comprises loosely coupled modular services (Siedersleben 2007). An enterprise service bus (ESB) is used to facilitate their communication and integrate the services (Papazoglou and Heuvel 2007). Even though these basic principles are found to be quite consistent throughout the literature, there are still numerous definitions of SOA in use, that vary with respect to their scope (Erickson and Siau 2008). Some are limited to the IT layer, some focus on the business layer, and others holistically include both the IT and the business layer:

- Krafzig et al. (2005, p. 57) present one example of a definition limiting SOA to the IT layer: "a Service-Oriented Architecture (SOA) is a software architecture that is based on the key concepts of an application frontend, service, service repository, and service bus."
- By contrast, Lublinsky (2007) adopts a business perspective: "SOA can be defined as an architectural style promoting the concept of business-aligned enterprise service as the fundamental unit of designing, building, and composing enterprise business solutions." This business-oriented view of service orientation was advanced by Janssen

and Joha (2008, p. 35) to define a Service-Oriented Enterprise (SOE): “The SOE is an enterprise that is modularized in business domains.” Organizations seeking to become a SOE will establish shared service centers for creating ”new products […] by orchestrating the services provided by the service centers” (2008, p. 35).

- Bieberstein et al. (2005a, p. 5) define SOA as a holistic concept covering both the business as well as the IT perspective: SOA is a ”framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities.”

Overall, the definitions reveal similarities but also differences with respect to the scope of SOA. In our work, we follow the holistic understanding of SOA that covers both the business and technical layers. Accordingly, we develop in the Methods section a unified multidimensional SOA adoption construct that serves as an instrument for capturing the degree of SOA adoption.

3 Research Model and Hypotheses

Our research model (Figure 1) adapts the technology-organization-environment (TOE) framework to the SOA context. Following Fichman (1992), our research addresses the organizational level of adoption, which makes modifications and extensions to traditional adoption models necessary. According to Jeyaraj et al.’s (2006a) findings from analyzing 51 studies, the dominant research paradigm for organizational adoption studies is based on three dimensions: innovation (i.e., the artifact to be adopted), organizational, and environmental characteristics. Hence, the TOE framework from DePietro et al. (1990) is often applied; it incorporates both internal and external determinants that influence the adoption of a (technological) innovation (such as SOA in our case). The TOE framework covers the three dimensions identified by Jeyaraj et al. (2006a) and has been applied successfully in different studies, such as those on the adoption of inter-organizational systems (e.g., Chau and Tam 1997; Mishra et al. 2007; Zhu and Kraemer 2005), and also supports our analysis of what leads a *potential* adopter to become a *genuine* adopter of SOA.

The TOE framework describes three (groups of) determinants that may influence the adoption of a technological innovation (DePietro et al. 1990, p. 153+154):

- *Technological context* describes “the internal and external technologies relevant to the firm”, which includes the current internal practices and equipment and all available technologies on the market.
- *Organizational context* captures all relevant properties of the organization that makes the adoption decision, such as firm size, managerial structure, human resources, or slack resources available.
- *Environmental context* is “the arena in which a firm conducts its business”, covering its industry and competitors, markets, access to external resources, and relationships with institutions.

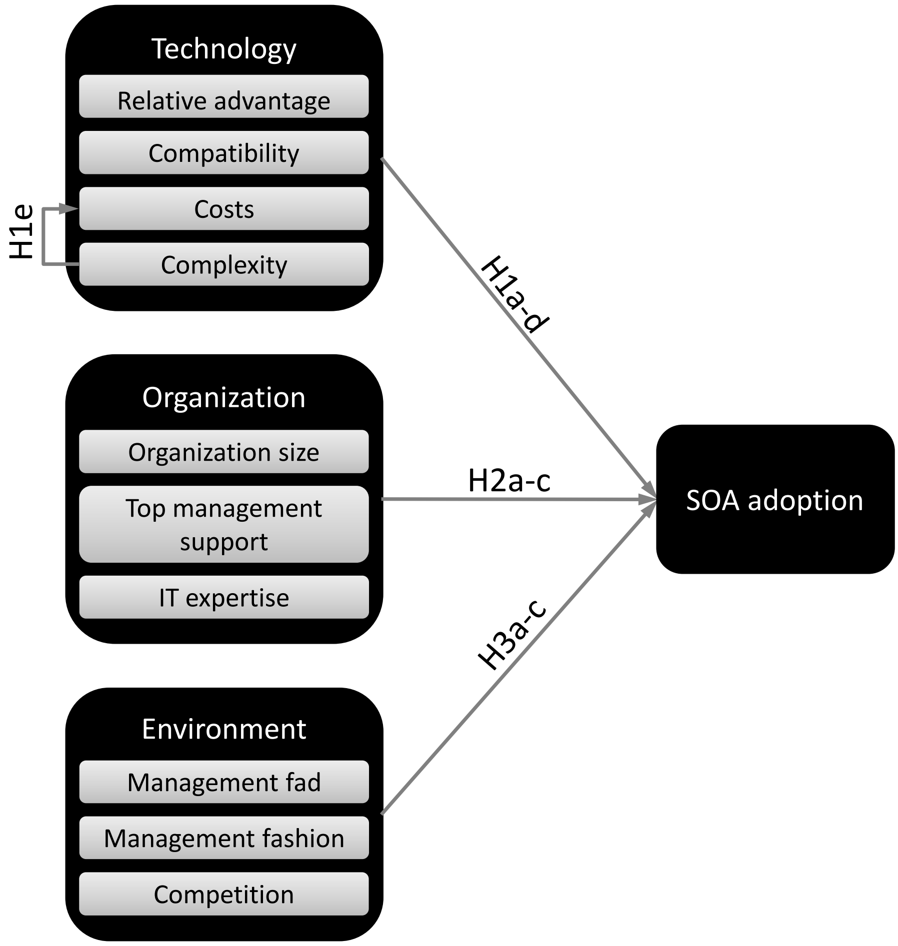

Figure 1. Research model

While the TOE framework defines these three contexts, it offers no details regarding which factors are important within each context. Additionally, Wolfe states that for organizational innovation attributes "no broadly accepted typology or check-list of attributes has emerged" (1994, p. 418). Comparing Wolfe's finding with Jeyaraj et al.'s review (2006a), which lists 100 different variables to predict organizational adoption, we see that nothing has changed over the last years.

Hence, we conducted a detailed literature review of how studies applying the TOE framework fill these three context "containers" (see Appendix for details). We analyzed 38 empirical quantitative studies of the organizational adoption of technologies based on the three contexts. These 38 studies represent only those papers that explicitly applied the TOE framework in a quantitative study investigating adoption issues (i.e., we included no case studies, conceptual works, and studies applying the TOE framework to business value studies, etc.). We extracted all adoption determinants from these 38 studies. Table 1 summarizes those determinants that are statistically significant in more than one of the 38 studies (Table 12 in the Appendix offers a detailed overview of all 318 factors). If a measure was assigned inconsistently to different TOE contexts among the studies, we assigned it to the context most often applied in the studies. Factors highlighted in bold are used in our subsequent model development and are explained further as we develop our hypotheses.

Context	Factors (examples of synonymous or comparable determinants within a single cell)	Number of studies	Number of times applied[1]	Times significant
Technology	**Compatibility**, Lack of Interoperability, Lack of Organizational Compatibility	25	50	31
	Relative Advantage, Perceived Usefulness, Perceived Direct Benefits, Perceived Indirect Benefits, Perceived Benefits	24	40	25
	Complexity, System Complexity, Perceived Barriers	13	21	7
	Cost, Perceived Financial Cost, Perceived Costs	6	9	3
Organization	**Organization Size**, Firm Size, Business Size, Size, Organizational Size	26	38	25
	IT Expertise, Employees' IS Knowledge, Perceived Technical Competence, Prior EDI Experience, HRIS Expertise, Application Knowledge	23	32	20
	Top Management Support, Managerial Beliefs, Managerial Obstacles, Management Support	15	24	17
	Scope, Firm Scope, Globalization Level, Global Scope, International Scope	7	10	4
	Financial Resources, Financial Slacks, Financial Commitment, Firm Profitability, Organizational Slack	8	8	7
Environment	**Competition**, Competitive Pressure, Competition Intensity, Industry Competition, Perceived Industry Pressure, External Pressure	25	39	26
	Regulatory Environment, Perceived Government Pressure, Government Pressure, Regulatory Policy, Government Policy, Government Influence	13	19	11
	Trading Partners Pressure, Business Partner Influence, Partner Readiness, (Lack of) Trading Partner Readiness	10	12	10
	External Support, Perceived Support from the Vendor, Customer Support	8	11	6
	Extent of Adoption Among Competitors[2], Inter-Organizational Dependence	5	8	4

Notes: [1] Reflects usage of a construct in multiple models within one paper and thus is equal or higher than “number of studies”

[2] We have investigated not only the “extent of adoption among competitors,” but also employed a more general concept (management fad).

Table 1. Summary of factors used in 38 quantitative studies applying the TOE framework

The measures highlighted in bold in Table 1 are used in the context of this study and also represent the most-often used and significant measures in the technological (compatibility, relative advantage, complexity, and costs) and organizational (organization size, IT expertise, and top management support) contexts. For the environmental context, we applied the most cited factor, but left out others because they are obviously less relevant for a firm-internal technology – in contrast to EDI or other forms of inter-organizational systems. The following sub-sections explain theoretically why the highlighted factors should be considered as SOA adoption determinants.

3.1 Technological Context

Our analysis of previous studies using the TOE framework (Table 1) shows that relative advantage, compatibility, costs, and complexity have been the most-often considered and most significant factors explaining organizational adoption based on the technological context. This is consistent with a meta-analysis by Tornatzky and Klein (1982), who extracted 30 innovation attributes from 75 articles in the literature and assessed the generality and consistency of the existing empirical findings. Their analysis revealed that relative advantage, complexity, and compatibility had the most consistent significant relationship to innovation adoption.

"*Relative advantage* is the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers 2003, p. 229, our emphasis). According to Yoon and Carter (2007), the motivations to adopt SOA can be distinguished into business and IT motivations. Thus, relative advantage is twofold, comprising of relative advantages from a business point of view and from an IT point of view. Reductions in future costs for running and developing the IT through the reuse of existing services, or an easier integration of internal applications, are examples of advantages associated with SOA on the IT layer (Baskerville et al. 2005; Bieberstein et al. 2005a). On the business layer, better integration of applications can lead to increased data consistency and straight-through processing (STP) (i.e., reducing media discontinuities) (Baskerville et al. 2005). In addition, IT can support new or changed business processes more quickly, thereby reducing time to market (Yoon and Carter 2007).

Hypothesis 1a (H1a): Firms that perceive more benefits from SOA are more likely to adopt SOA.

"*Compatibility* is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers 2003, p. 240, our emphasis). As SOA is an instrument for handling the entire enterprise architecture so as to adapt business processes to changes in the environment (Brahe 2007), it is particularly compatible with that have IT-intense business processes. For example, handling the problems that arise from dense IT structures is a reason for adopting SOA (Tewary et al. 2009).

Hypothesis 1b (H1b): The more compatible SOA is with an organization's IT setting, the more likely the organization will adopt SOA.

"*Costs* involved in implementing an innovation including initial investment, operational costs, and training costs" (Jeyaraj et al. 2006b, our emphasis) are incorporated because adopting SOA requires a significant investment (Choi et al. 2010; Tewary et al. 2009). These costs are related to the efforts involved with implementing SOA, such as human resources (own employees and external consultants), set-up costs for new organizational structures, education of existing employees (Bieberstein et al. 2005b; Ciganek et al. 2005; Tewary et al. 2009), and so on. All these costs are much more predictable than are the advantages to be realized from adopting SOA. Thus, anticipated costs will negatively influence SOA adoption.

Hypothesis 1c (H1c): The higher the perceived costs, the less likely that an organization will adopt SOA.

"*Complexity* is the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers 2003, p. 257, our emphasis) and comprises factors that influence the SOA adoption negatively, such as the difficulties in identifying service candidates from business processes or encapsulating functionality into modular services (Bieberstein et al. 2005b; Ciganek et al. 2005). Based on an analysis of five case studies, Schelp and Aier (2009) have shown that firms, that adopted SOA faced increasing complexity, which needs to be addressed lest the advantages of adopting SOA will be only temporary.

Hypothesis 1d (H1d): Organizations that perceive SOA as complex are less likely to adopt SOA.

Moreover, the complexity involved with implementing and managing an SOA convert primarily into higher costs. For example, it is difficult to identify service candidates among business processes or to develop modular services; this will require employee training and/or recruiting new employees or bringing in external consultants to support the organization (Choi et al. 2010; Tewary et al. 2009). Therefore, high complexity does not only decrease the likelihood of SOA adoption in a direct way, but also increases the anticipated costs of an SOA implementation.

Hypothesis 1e (H1e): A higher degree of complexity will increase the perceived costs associated with SOA.

3.2 Organizational Context

The analysis of previous studies using the TOE framework revealed organization size, top management support, and IT expertise as the factors most often used and most significant for the organization context, which matches with Jeyaraj et al.'s review (2006a) of organizational IT innovation. They found that organizational size and top management support are the most frequently considered adoption determinants (beside the constructs of the *technological* context mentioned earlier).

"*Organization size* [is] typically measured using revenues or number of employees" (Jeyaraj et al. 2006b, our emphasis) and has been identified as an important factor influencing technology adoption (Thong 1999; Tornatzky and Fleischer 1990; Zhu et al. 2003). Larger firms in particular seem to adopt SOA, as they tend to face more problems from "an extremely complex network of enterprise applications, each based on different application architectures" (Tewary et al. 2009, p. 1). Also, larger organizations are expected to have more (slack) resources to support adopting SOA (Goode and Gregor 2009).

Hypothesis 2a (H2a): Larger organizations are more likely to adopt SOA.

Top management support is "the extent to which institutional leadership is instrumental in fostering an innovation" (Jeyaraj et al. 2006b) and considered important for the adoption of new IS (Lederer and Mendelow 1988). Case studies have shown that SOA adoption is often driven by the IT department and that support from the top management is a critical aspect for successful implementation (Yoon and Carter 2007).

Hypothesis 2b (H2b): The more top management supports SOA, the more likely a firm will adopt SOA.

IT expertise, part of the professionalism of the IT workforce, is defined as "education, expertise, skills, and related knowledge of IS employees" (Jeyaraj et al. 2006b). A lack of technological expertise can force an organization to postpone adoption of an innovation (e.g., Kuan and Chau 2001; Thong 1999). Since SOA adoption is a very complex venture, SOA-related expertise among the firm's IT employees is critical; if it is unavailable, employees must be intensely trained (Tewary et al. 2009; Yoon and Carter 2007).

Hypothesis 2c (H2c): The higher the SOA-related IT expertise of IT employees, the more likely an organization will adopt SOA.

3.3 Environmental Context

With respect to the environmental context, SOA is different from other IT innovations studied before. Of the 38 studies analyzed, 27 investigate the adoption of interorganizational systems

(IOS) such as E-Business, EDI, or E-procurement, for which adoption depends strongly on the adoption behavior of the environment (that of potential and actual business partners in particular). This explains the prominence of trading partners' pressure as an adoption determinant of the environmental context in previous studies. By contrast, SOA adoption initiatives are usually motivated (at least in the beginning) by firm-*internal* change in terms of improving efficiency and flexibility – for example, internal integration of an organization's systems and reuse of functionality or services to increase end-to-end integration of business processes. This is supported by the case studies of Yoon and Carter (2007) regarding SOA implementation: they identified no motive related to external influences but various motivations related to firm-internal aspects. Consequently, we argue that other firms (partners or competitors) do not put direct pressure on a firm to adopt SOA, because B2B interaction is barely affected by the design of a firm's internal architecture. Although the integration of business partners can be easier with an SOA (Löhe and Legner 2010), this is not a primary adoption driver. However, since SOA can facilitate B2B integration, this is a benefit argument (and thus captured by the corresponding construct within the technology context). Further, regulatory environments do little to force an organization to adopt or not adopt SOA. Thus, we have not included the different forms of external pressure and influences applied in earlier studies.

However, rather than eliminating the entire environmental context we consider the level of competition and further follow Fichman (2004) and Robey et al. (2008), who claim management fashion to be a promising opportunity for future, more innovative studies of IT innovation that would investigate the impact managerial fads and fashions have on adopting a technology despite that they may be inefficient for the adopting organization. Management fashion and fad address the situation that organizations imitate other organizations' adoption decisions in uncertain environments (Abrahamson 1991). This can also be seen as a more specific investigation of the "extent of adoption among competitors" factor, used in previous studies investigating the TOE dimensions (Table 1).

Management fad points to an organization's behavior to imitate other organizations belonging to the same group (e.g., competitors, peers, or business partners) (Abrahamson 1991). Consequently, from a management fad perspective the decision to adopt SOA is driven by the fact that competitors or peers have adopted SOA, so an organization does the same to avoid facing a potential competitive disadvantage. An example of this behavior is the use of "reported SOA success stories among peers and competitors […] [as] frequent justification for whether adoption of the technology is a good fit for an organization" (Choi et al. 2010, p. 255).

Hypothesis 3a (H3a): Management fad positively influences the degree of SOA adoption.

By contrast, *management fashion* captures the imitation of adoption decisions by firms that do not belong to the same group as the organization they are imitating (Abrahamson 1991), as documented in, for example, analyst reports and whitepapers, or as reported by consultants. We hypothesize that the expectations of organizations regarding SOA adoption are "driven by vendors, analysts, and consultants" (Schelp and Aier 2009, p. 1), leading to the so-called "SOA hype."

Hypothesis 3b (H3b): Management fashion positively influences the degree of SOA adoption.

Finally, *competition* assesses the "intensity and extent of competition"(Jeyaraj et al. 2006b) in the market within which a firm operates. Although neither the government, business partners, or competitors directly force an organization to implement SOA, the level of competition in the market can affect the decision to adopt SOA. One would expect that SOA would be adopted especially in cases where a firm operates in a highly competitive market, to enable the IT responding faster to changes (Pavlou and Sawy 2010; Tiwana and Konsynski 2010).

Hypothesis 3c (H3c): A higher level of competition increases the degree of SOA adoption.

To increase the theoretical validity of our model and the selection of the adoption determinants, we add a structured approach to gather demonstrative support from the SOA literature. For each of the TOE factors, Table 8 in the Appendix presents an exemplary quote from the related SOA literature that supports the inclusion of the factor.

4 Research Method and Data

4.1 Methodology

4.1.1 Data Collection

To evaluate the model, we applied a quantitative approach and conducted a survey with firms from the German service industry, covering several sub-industries such as logistics/trade, financial services, media and telecommunication and others (i.e., US SIC codes 4,000 to 8,999). We chose the service industry because of the relatively important role of IT compared to other resources such as production facilities, raw materials, and so on. In the service industry, IT is, besides HR, often the only "production factor"; this allows for controlling industry characteristics that otherwise might covariate our results.

We contacted firms in the Germany service industry by phone to identify the leading IT architect and request participation in the survey. This led to 955 personally identified contacts. Data were collected by mailing a paper-based questionnaire. After several reminders (via mail and phone), we eventually received 174 questionnaires (response rate = 18.2%). Figure 2 provides descriptive statistics on the population and responding firms as to firm size and industry sector.

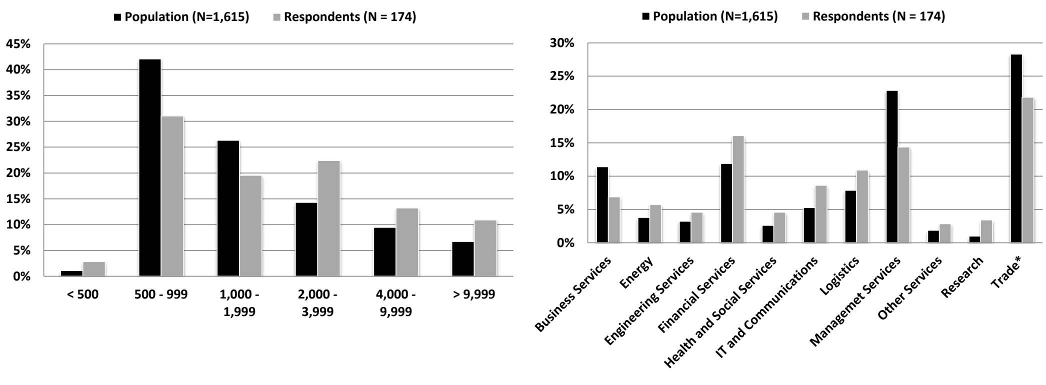

Figure 2. Left: distribution of firm sizes based on number of employees; right: distribution of sectors within the services industry (* some trade firms also produce the traded goods)

The sample does not perfectly resemble the population since it includes slightly larger firms and companies that are more IT-reliant (e.g., banks and logistics providers rely more on a sophisticated IT infrastructure than do management consulting or real estate firms); therefore, the sample may show a higher degree of SOA adoption than the overall population. SOA maturity is still not very high in the industry, though, and because we were looking for a sample that would provide sufficient variance in SOA adoption, this favors our selection of these firms for the study.

As some of the 174 responses showed single missing values, we followed the suggestions of Kristensen and Eskildsen (2010), who simulated the effects of applying various strategies for handling missing values and show that using the expectation-maximization (EM) algorithm is associated with more valid and reliable model estimation results than mean value replacement or pairwise deletion. Thus, we applied the EM algorithm in a very conservative way only to those questionnaires with four or fewer missing values regarding the items in our research model (i.e., < 10% missing values) and eliminating the remaining data for evaluating our model. As a result, we used 154 questionnaires for the calculations that follow.

To analyze the data and test our research model, we used PLS (smartPLS 2 M3 (Ringle et al. 2007)) and IBM SPSS Statistics 19.

4.1.2 Measurement

The items used for measuring the adoption determinants were derived from previous TOE-based studies where possible and adapted to the SOA context through a review of the literature as well as additional insights from our own case studies conducted prior to the survey. The items for assessing the degree of SOA adoption were developed for this study[16] because no adequate measurement model for SOA adoption is available in other studies.

As a foundation for designing the survey, we not only reviewed the literature on SOA and adoption but also undertook case studies in nine firms in the German service industry. As part of the case-study interviews, we examined the different approaches organizations take when implementing SOA, as well as the drivers of SOA adoption. The interviews also helped us to learn SOA lingo from experts as well as gain further valuable insights into our model.

We also engaged a group of seven researchers experienced with SOA to assess our measurement items with respect to whether our formulations might be ambiguous, unclear, or too lengthy. An industry panel of consultants experienced with SOA projects also assessed these items and their content validity. Based on these additional inputs, we revised our measurement instruments accordingly. The experts suggested no additional items; hence the items seem to cover the content domain adequately (Lewis et al. 1995). Overall, these validation approaches increased the validity of the measurement instruments by identifying ambiguous or unsuitable questionnaire items.

In the following section, we explain in detail how we measured both the adoption determinants and the degree of adoption.

Measuring the SOA Adoption Determinants

Most constructs were operationalized by reflective multi-item measures (shown in Table 5 in the Appendix). By contrast, *relative advantage* is conceptualized as a second-order construct formed by *relative advantage for business* and *relative advantage for IT*, each measured by three formative items. *Compatibility* was measured in a formative way, as well, and assesses the degree of IT support of five different areas of operations (production, procurement, etc.). For the model estima-

[16] The validation of the instrument was presented at an International IS conference (Joachim et al. 2011).

tion, we used a summated scale (weights derived from a confirmatory factor analysis). For measuring *organizational size*, the total number of employees was retrieved from secondary data sources and used in logarithmic form during the model estimation.

As controls for ruling out rival theories, we apply: the organization's total IT budget, the number of years the respondent has worked for the surveyed organization, and the industry sector.

4.1.3 Conceptualization and Operationalization of the SOA Adoption Instrument

Taking into account the different definitions given for SOA, we first develop a multidimensional SOA concept that comprises the diverging views. These different dimensions allow for a sophisticated and holistic perspective on the degree of SOA adoption in organizations and also enable a comprehensive measurement of SOA in empirical research. Our SOA construct has four complementary dimensions, which are derived from common enterprise architecture frameworks.

Since both practitioners and the academic literature associate different meanings with SOA (see section 2), a consistent overarching conceptualization is important for valid SOA research and for answering our research question about why firms adopt SOA. SOA adoption, as the main variable in our research model, has been conceptualized rarely and only rudimentarily in earlier studies. Consequently, using existing concepts (and related measures) for investigating the extent of SOA adoption in a firm is nearly impossible. For example, Kumar et al. (2007), in their conceptualization of SOA, focus only on the binary assessment of two technologies often used for implementing SOA (Web Services and XML), whereas Tafti et al. (2008, p. 13) consider ”the deployment of services-based architecture” and ”the number of business functions for which SOA is used” as additional items, thus empoying four single items to measure SOA. By contrast, Oh et al. (2007) consider the architectural design principles of service orientation and additional technologies related to SOA (i.e., XML, WSDL, SOAP, and UDDI). Consequently, as the different operationalizations of SOA vary according to the different definitions, we need a unifying SOA research concept that is comprehensive enough to capture SOA in a holistic way.

To capture SOA adoption holistically and unify the previous definitions and conceptualizations, we propose to assess the level of service orientation of the entire enterprise architecture (EA) as well as at each of its layers. While there are different popular EA frameworks with different numbers of layers (Table 3), they can be easily mapped to each other. We followed Meschke and Baumoel (2010), who mapped Winter and Fischer's (2007) EA representation based on five layers to another EA representation comprising only three layers. Thus, we conceptualize SOA with three different EA layers, which is consistent with most of the literature and with the widely used TOGAF 9 EA framework (The Open Group Architecture Framework) (The Open Group 2009).

TOGAF 9 (The Open Group 2009)	Meschke and Baumoel (2010)	Brown and Kara-mouzis (2001)	Winter and Fischer (2007)
business architecture	**process architecture**	**business process**	**business architecture**
			process architecture
IS architecture (data and application architecture)	**application architecture**	**business applications**	**integration architecture**
			software architecture
technology architecture	**system architecture**	**infrastructure**	**technology architecture**

Table 3. Comparison of enterprise architecture frameworks

To capture the degree of SOA adoption in an organization holistically, our conceptualization of SOA draws on the concept of EA and captures the degree of service orientation in each of the following three architecture layers as proposed by TOGAF 9: business architecture, IS architecture, and technology architecture. Additionally, we investigate the fit of service orientation between these three architecture layers to assess vertically the fit and actual use of SOA within all layers. Thus, we capture SOA adoption using the following four dimensions:

(1) *Service-oriented business architecture*: The degree of service orientation of the business architecture is captured by investigating whether business activities are designed and managed following a service-oriented paradigm within the business layer. For example, services-based modeling concepts for modeling business processes should be used to identify the core capabilities of an organization. Also, an organization with a high degree of service orientation in the business architecture should be organized such that it is able to offer and run centralized and non-redundant (shared) business service (Janssen and Joha 2008).

(2) *Service-oriented IS architecture*: This aspect captures the extent to which the IS architecture is in line with the service-oriented paradigm. Typical design principles associated with service orientation at the IS architecture include loose coupling, abstraction, composability, and the division of reusable logic (Erl 2004).

(3) *Service-oriented technology architecture*: The extent of service orientation of the technology layer is investigated with respect to using technologies related to implementing SOA, for example, XML, Web Services, Enterprise Service Bus (ESB), service registry/repository, and business process execution language (BPEL) (Kumar et al. 2007; Oh et al. 2007).

(4) *Fit of service-oriented architectures*: In addition to investigating each of the three proposed layers of EA separately, it is also important to assess the alignment of each of these architectures. Thus, this additional dimension assesses the degree to which SOA is used (in terms of each of the three dimensions described just above: (1), (2), and (3)) to support particular business processes in the organization. This dimension thus assesses the fit of the three architectures, as business processes can be implemented only using service orientation if all three architecture layers are aligned for that particular business process.

This multidimensional SOA research concept, which is based on the well-established concept of enterprise architecture, allows us to integrate the various definitions and conceptualizations found in the literature. Moreover, it supports defining a comprehensive measurement model to capture empirically a more complete picture of the degree of SOA adoption and, consequently its influencing factors.

Table 6 in the Appendix summarizes the operationalization of the SOA adoption construct.

After data collection was completed, we conducted an exploratory factor analysis (EFA) on the 16 items with varimax rotation in and retained all factors with eigenvalues greater than .98. The results presented in Table 7 in the Appendix show that the EFA revealed five components. Three reflect perfectly three of the four proposed SOA dimensions. The other SOA dimension (i.e., service-oriented technology architecture) devolves to two components, which further emphasizes the formative nature of the different technologies and standards comprised in this dimension. Without exception, all items load highly (loading > .45) on their associated factors, confirming the construct validity of the developed *SOA adoption construct*. For the final operationalization of our SOA adoption construct in the model estimation, we use the five retained factor scores as five formative indicators. In so doing, we could avoid using a second-order construct as a dependent variable, whose R^2 would be completely formed (and explained) by its first-order constructs and thus make an analysis of the impact of the different adoption determinants impossible.

4.2 Data Quality and Measurement Model

Some of our item scores show slight deviations of kurtosis and skewness from normality (Table 9 in the Appendix). Also, the Kolmogorov-Smirnov test supports that our data is not sufficiently normally distributed. This, the rather limited sample size, and the fact that PLS is "well suited for exploratory research" (Gefen et al. 2011, p. V) in contrast to covariance-based SEM led us to use PLS to test our research model, which is the first quantitatively evaluated model explaining the determinants of SOA adoption.

We also analyzed the data regarding *non-response bias*. Comparing the answers given showed no significant differences between those respondents who answered directly and those who answered only after a reminder. (The answers of the late-respondents are usually used as a proxy for those firms, that did not answer at all, according to (Armstrong and Overton 1977)).

After ensuring the quality of the basic data, we tested the PLS measurement models for validity and reliability. All loadings of the reflective items are larger than .707, as requested by Nunnally (1978) (Table 9 in the Appendix). Further, the composite reliability (C.R.) is larger than .7 (Nunnally 1978) for all constructs with reflective measures, and the average variance extracted (AVE) is larger than .5 (Chin 1998) in any case (Table 10 in the Appendix).

Finally, was successfully checked the *discriminant validity* by ensuring that all inter-construct correlations are lower than the square root of the AVE (Gefen et al. 2000) (Table 10 in the Appendix). Moreover, we assessed that all indicators had the requested high loadings on their associated constructs, while having low loadings on all other constructs, as another check for discriminant validity (Table 11 in the Appendix).

After ensuring the validity and reliability of the reflective measurement models, we tested the formative measurement model of our SOA adoption construct as well as the formative first-order constructs forming relative advantage (business and IT). The outer weights of all five indicators of our SOA adoption construct are highly significant at $p \leq .01$, using the bootstrapping procedure with 2.000 samples (Table 9 in the Appendix). As the five indicators result from the factor analysis described in Table 5, they do not correlate with each other and have variance inflation factors (VIFs) of 1, which means that multicollinearity does not exist. The six indicators forming the two constructs measuring the relative advantage of IT as well as business each contain one indicator, which is either not significant (RAI1) or only significant at $p \leq .1$ (RAB3) (Table 9 in the Appendix). The VIFs vary between 1.239 and 1.469 for relative advantage (IT), and between 1.162 and 1.522 for relative advantage (business), which are well below 3 as suggested acceptable VIFs (Cenfetelli and Bassellier 2009; Diamantopoulos 2011). As both indicators contribute to the completeness of the formatively measured constructs, we kept them in the model, which will make identifying significant relationships between relative advantage and SOA adoption more difficult.

4.3 Test of the Proposed Research Model

Figure 3 shows the results of testing the SOA adoption model with PLS: path coefficients, their levels of significance (bootstrapping with 2,000 samples), and the R^2 of SOA adoption and costs. We also included the control variables *IT budget*, number of *years employed*, and *industry type*.

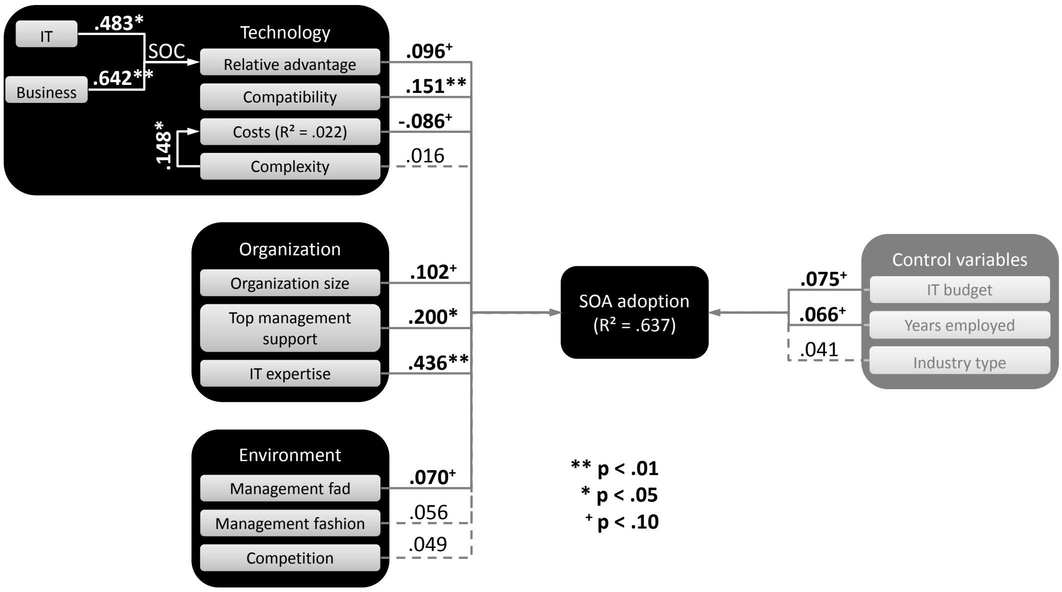

Figure 3. Model test results

The TOE-based determinant model explains a substantial part of SOA adoption (R^2 = 63.7%). While IT expertise is by far the most important factor influencing SOA adoption, top management support and compatibility also show highly significant positive relationships. As expected, the costs associated with adopting SOA negatively influence adoption, but only weakly. Complexity does not have a direct significant impact on adoption, but is related to costs as proposed. Finally, it is noteworthy that relative advantage, organization size, and fad show only weak relationships to SOA adoption, while management fashion and competition do not contribute at all.

Investigating the R^2 of SOA adoption in a baseline model containing only the control variables but none of the TOE determinants reveals that the control variables alone only account for 25.1 percent. Thus, the TOE determinants show very high explanatory power regarding SOA adoption by explaining further 38.6 percent of the variance of SOA adoption.

Finally, Table 6 provides the single effect sizes of each construct used to determine SOA adoption. For calculating the f^2, we compared the R^2 of the model with and without the particular construct or context (Cohen 1988). According to Chin (1998) a f² of .02, .15, and .35 can be viewed as a small, medium, or large effect of a predictor. Thus, only expertise has a medium effect, while relative advantage, compatibility, and top management support have only small effect sizes on SOA adoption. Aggregating the different arguments to the three TOE contexts, it becomes clear that organizational is by far the most important context for explaining SOA adoption.

Context	Construct	f² (construct)	f² (overall context)
Technology	Relative advantage (IT & business)	.02$^+$	.07$^+$
	Compatibility	.05$^+$	
	Costs	.01	
	Complexity	.00	
Organization	Organization size	.01	.55**
	Top management support	.05$^+$	
	IT expertise	.25*	
Environment	Management fad	.01	.03$^+$
	Management fashion	.01	
	Competition	.01	
Control	IT budget	.01	.02$^+$
	Years employed	.01	
	Industry type	.00	
Note: **: large effect, *: medium effect, $^+$: small effect according to Chin (1998)			

Table 6. Single effect sizes (f²) on SOA adoption

4.4 Cluster Analysis of SOA Adoption Patterns

We conducted a cluster analysis to explore whether different SOA adoption patterns exist among the firms investigated. This analysis not only supports the identification of different SOA adoption patterns, but also has the potential to compare whether specific differences within the adoption determinants lead to different configurations along the four SOA dimensions.

Following Malhotra et al. (2005), we used a two-stage approach that combines hierarchical and non-hierarchical clustering methods. First, we normalized the values of each indicator to a range from 0 to 1 and then calculated the mean for each construct based on its indicator scores. In the first stage of the cluster analysis, we conducted hierarchical clustering using Ward's method based on the squared Euclidean distance, "which tries to minimize the total within-group or within-cluster sums of squares" (Sharma 2008, p. 193), using the four dimensions of the multidimensional SOA adoption construct as inputs. Next, to determine the number of clusters, we assessed the coefficients created by Ward's method as well as the dendogram (Malhotra et al. 2005) and the means. According to these results, we chose the solution based on five clusters (representing five different SOA adoption patterns), since solutions based on less clusters were related to a rapidly increasing Ward's coefficient while those with more clusters lacked discriminatory power or resulted in less meaningful clusters (Rai et al. 2006). In the second stage, we used the non-hierarchical K-Means algorithm to assign every respondent firm to one of the five identified clusters.

Figure 4 presents the characteristics of each of the five identified clusters with respect to the four dimensions of the multidimensional SOA adoption construct as well as the allocation of the organizations to these clusters. *Cluster 1* covers those organizations that are not service-oriented with respect to any of the four dimensions. Organizations belonging to *Cluster 2* limit their service-oriented activities to the business architecture. *Cluster 3* represents organizations with a medium degree of service-orientation at three of the four dimensions, but still exhibiting a low service-oriented fit between the three architecture layers. Organizations that increased the degree of service orientation of both their IS architecture and their business architecture belong to *Cluster 4*. Finally, firms in *Cluster 5* show a relatively high degree of service orientation at all three layers of the enterprise architecture and strong fit among them. However, there is still space for increasing the level of service orientation, as most of these organizations have not achieved the maximum degree of service orientation.

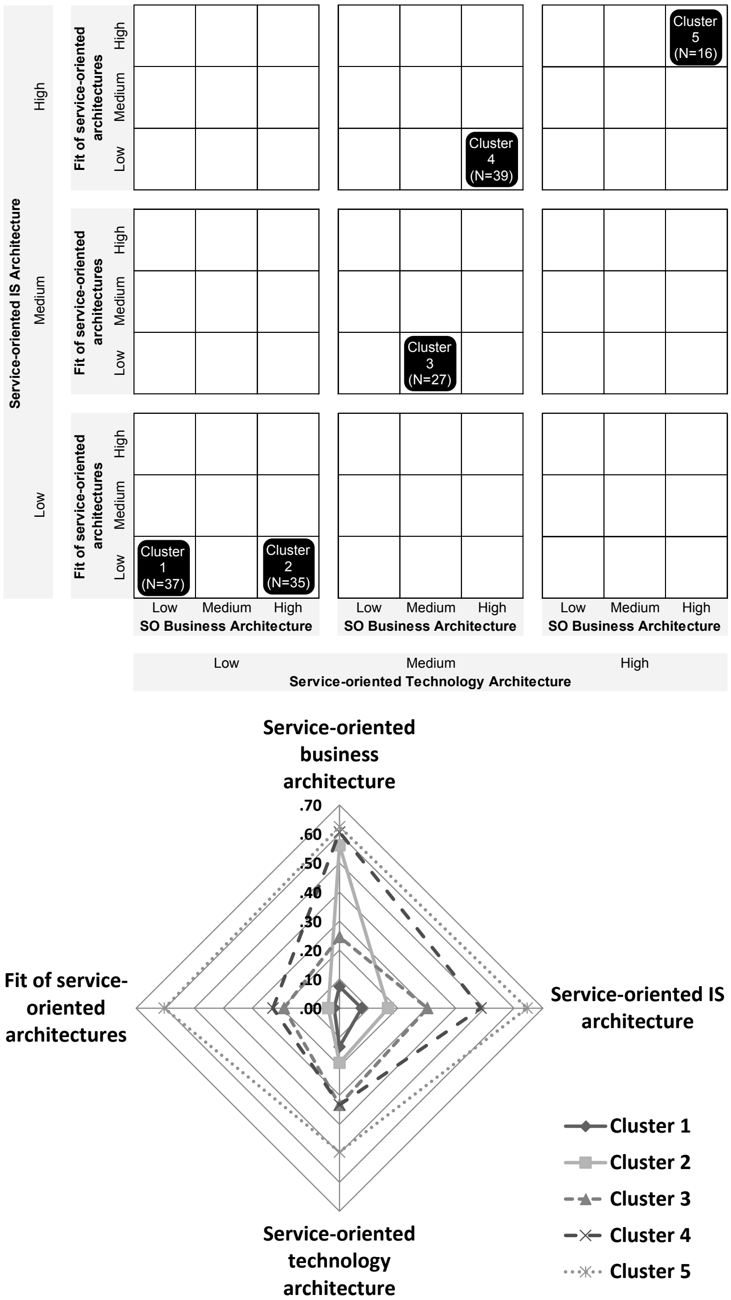

Figure 4. Identified SOA adoption patterns

Table 7 shows the results of the group mean analysis. The first rows cover the four dimensions of the multidimensional SOA adoption construct, while the following rows represent the different adoption determinants and control variables. As we have normalized the values to a range from 0 to 1, "neighbored" clusters show relatively small absolute differences.[17] In order to test whether the group medians are statistically different, we used the Jonckheere-Terpstra test, which uses "information about whether the order of the groups is meaningful" (Field 2009, p. 568) to evaluate trends among the identified adoption patterns (Field 2009). As the cluster numbers per se already reflect an increasing degree of service orientation, the Jonckheere-Terpstra test reveals the relationship between the different adoption determinants and the firm's degree of achieving a holistic degree of service orientation at all layers of the enterprise architecture. The last column of Table 7 shows that all determinants except competition show significant increasing trends along the clusters. Further, despite the highest effect size of top management support and IT expertise, it is noteworthy that management fashion is identified as the third-most important determinant. Looking at the group means among the five clusters, we can see that management fashion remains stable for Clusters 1 and 2 and increases for Clusters 3, 5, and 5. Thus, organizations, that have adopted SOA beyond the business layer alone are confronted with (and maybe partly driven by) management fashion. Finally, the results of the cluster analysis support all hypotheses except the one for competition.

	Cluster 1 (N = 37)		Cluster 2 (N = 35)		Cluster 3 (N = 27)		Cluster 4 (N = 39)		Cluster 5 (N = 16)		Jonckheere-Terpstra-Test
	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	effect size
SO business architecture	**.07**	.11	**.56**	.15	**.25**	.12	**.61**	.11	**.63**	.19	**.66** **
SO IS architecture	**.08**	.08	**.17**	.12	**.30**	.14	**.49**	.13	**.65**	.12	**.94** **
SO technology architecture	**.13**	.09	**.19**	.14	**.33**	.18	**.33**	.15	**.50**	.17	**.62** **
Fit of SO architectures	**.02**	.05	**.04**	.08	**.19**	.15	**.23**	.15	**.60**	.11	**.80** **
Relative advantage	**.49**	.24	**.55**	.20	**.58**	.13	**.58**	.15	**.72**	.12	**.25** **
Compatibility	**.68**	.16	**.76**	.15	**.73**	.17	**.73**	.13	**.83**	.12	**.20** **
Costs	**.74**	.18	**.73**	.17	**.72**	.19	**.65**	.21	**.66**	.19	**-.15** *
Complexity	**.64**	.21	**.58**	.19	**.56**	.21	**.56**	.18	**.43**	.21	**-.25** **
Organization size	**.34**	.11	**.33**	.16	**.40**	.17	**.39**	.17	**.44**	.18	**.16** *
Top management support	**.18**	.19	**.33**	.26	**.36**	.22	**.49**	.21	**.72**	.20	**.60** **
IT expertise	**.25**	.20	**.33**	.21	**.40**	.22	**.51**	.17	**.75**	.21	**.58** **
Management fad	**.51**	.20	**.59**	.25	**.65**	.21	**.62**	.21	**.63**	.26	**.22** **
Management fashion	**.19**	.15	**.22**	.17	**.28**	.19	**.33**	.21	**.39**	.18	**.36** **
Competition	**.58**	.20	**.58**	.21	**.54**	.21	**.58**	.24	**.64**	.26	.03

Note: **: p ≤ .01; *: p ≤ .05, significant results are highlighted

Table 7. Cluster centers and group mean analysis

4.5 Testing for Common Method Bias

To control for *common method bias* (CMB) in terms of context and items ordering bias, we used different scale formats for the various constructs and distributed two versions of the questionnaire with altering item sequences (Table 2 and Table 4). Applying the Kolmogorov-Smirnov test shows, with the exception of one indicator (EXP1 at $p \leq .05$), no significant deviations between the two versions of the questionnaire.

[17] However, while, the difference between cluster means of Cluster 1 and 2 is only .09 for service-oriented IS architecture, for example, Cluster 2 has a by 112.5 percent higher degree of service orientation.

Further, we applied the Harman single factor test, which uncovered that no single component explains only 25.5 percent of the total variance shared by all indicators, clearly not the majority. Moreover, we used a theoretically unrelated marker variable ("Our corporate strategy pursues leadership in innovation/ differentiation." rated on a 7-Likert scale from "no aim" to "most important aim") as proxy for a common method factor and tested for the impact of CMB on our model test results (Lindell and Whitney 2001; Podsakoff et al. 2003). We did this by linking the common method factor to all dependent latent variables (SOA adoption and costs). Comparing the results between the model with and without the method factor shows only one minor structural difference: the significance of one path (H3a: management fad → SOA adoption) drops from $p \leq .1$ to insignificant. All other hypothesized paths remain at the same level of significance. The largest absolute difference between the path coefficients is .013 and the R^2 values of SOA adoption and costs remain completely unaffected. Based on these CMB tests, we can assume that CMB is not likely to be a major issue in our data.

5 Discussion

First, we can conclude that the proposed model explains a substantial part (i.e., 63.7%) of SOA adoption. In addition, the cluster analysis reveals five main patterns of SOA adoption among organizations.

While the separation of relative advantage into IT and business aspects is confirmed, relative advantage itself represents only a minor driver of SOA adoption ($f^2 = .02$). The following quote from one of our case studies[18] serves as an entry point for discussing this rather unexpected result.

> *"One can easily see that we can reduce costs if we reduce the number of interfaces from five to one. Have we achieved this now or was this our aim? Clearly, the answer is no." (Bank B, chief architect)*

Even though the organizations are aware of the advantages associated with SOA (e.g., reducing costs), IT advantages alone do not help IT departments convince sponsors in the business departments to finance SOA projects. To adopt SOA successfully throughout the entire organizations, IT departments must consider and justify whether SOA is compatible with the business demands. Otherwise, the business departments, which often are the decision-makers regarding the necessary funding, will not invest in SOA. This creates a start-up problem for SOA adoption:

> "*Simplifying the IT landscape delivers nothing for the business per se. And whether it can really be operated at lower costs in the future is yet to be determined. From my point of view, IT has to speak a language that business understands if they want to make their benefits apparent. Anyone who can't do this, will have a start-up problem.*" *(Bank B, chief architect)*

This dialogue with the business and the analysis of the business processes ultimately leads to a decision, as to whether SOA is compatible with the existing setting or whether another solution would be more suitable:

[18] The case studies were introduced earlier in section 4.1.2.

> "*Whether it will be an SOA-based implementation or a monolithic system always depends very strongly on the particular demands of the business processes.*" *(Recycling services company, vice CIO)*

Further, the costs associated with implementing SOA are taken into account and negatively influence the adoption of SOA. However, the perceived complexity of introducing SOA does not affect SOA adoption directly; rather it is seen solely as a cost driver. Correspondingly, the literature review of the TOE factors shows that complexity was only significant in one-third of the applications we found. This may indicate organizations' attitude that money can solve all problems that may arise from SOA implementation-related complexity. It remains open whether this perception of the chief IT architects holds true or whether it reflects a lack of sensitivity to the huge organizational complexity of firm-wide and holistic SOA implementation. An indication for the former is that most firms do not try to implement SOA on their own, but instead leverage the knowledge of consultants, which turns handling complexity into explicit costs:

> "*On my projects, we have meetings, agreements, daily and even hourly consultations. I need a lot of consultants here. All of the consultants, who have done this [introduced SOA here] have been external.*" (*Recycling services company, vice CIO)*

An example of the explanation that sensitivity to the enormous complexity of a holistic SOA implementation is lacking is provided in another interview:

> *"Then we analyzed the situation together with consultants, especially the alliance of the enterprise service bus and business process management. It was extremely expensive, extremely complex, as well as cumbersome." (Bank A, IT architect)*

When looking at the organizational determinants, we find that employees' IT expertise is the single most important driver of SOA adoption and has the highest explanatory power (f^2 = .25). In addition, top management support and, to a lesser degree, organizational size are important. Thus, the organizational determinants can be interpreted as necessary conditions an organization must ensure; they are important to achieve a high degree of SOA adoption with respect to all four dimensions of the multidimensional SOA adoption construct (f^2 = .55). The last determinant, organization size, cannot be influenced by an organization wishing to adopt SOA. However, organization size is often associated with slack resources (Goode and Gregor 2009), which are a third critical factor for implementing SOA in the entire organization. Thus, ensuring that personnel as well as financial resources are available is another important prerequisite in addition to IT expertise and top management support.

In the environmental context, only management fad has a weak influence, while, in contrast, management fashion remains insignificant. A firm's SOA adoption seems to depend more on observable SOA adoptions from other firms ("same group") than on information from media, consultants and other sources ("outside group"). However, looking at the results of the cluster analysis, management fashion is the determinant with the third-largest effect size. Thus, we can conclude that, with respect to SOA, decision-makers indeed consider what others write or think:

> *"To be sure SOA was being discussed in the outside media and everyone, beginning with the executives, asked: 'What are we actually doing about that?'" (Bank B, chief architect)*

As the cluster analysis reveals, the perceived level of management fashion is relatively low in Clusters 1 and 2 while higher in Clusters 3, 4, and 5. Comparing these results with the insignificance of management fashion in PLS indicates that fashion does not affect SOA adoption continuously throughout increasing service orientation (insignificant in PLS), but plays a role only in the move from Cluster 2 to 3.

In addition, it indicates[19] that managers' uncertainty about the actual costs and benefits of SOA is reduced more effectively by their "own" observations than by reports. This could also be something learned from the media hype around SOA a few years ago. In our case studies, we saw that firms visit other organizations to observe how they have implemented SOA, which also supports the differential effect between management fad and fashion.

> *"Of course, we have talked to other firms – not necessarily with competitors, but others in the financial services industry." (Fund management company, managing IT director)*

Finally, competition was not significant (neither in SEM nor in the cluster analysis), which differs from TOE-based adoption studies focusing on IOS such as E-Business, EDI, or E-procurement (in those, competition was identified to be significant in 26 of 39 applications). Although SOA promises increased organizational flexibility, it seems that firms do not perceive SOA as the "Holy Grail" that will enable them to deal with competition in their industries – as often proposed.

Limitations

Our research has some limitations. First, we had to adapt or develop some of the measurement instruments for the purpose of this study. However, as the overall evaluation of the measurement model shows it to be of comparatively high quality, this seems not to be a major issue. Second, like most survey-based studies, our research may be subject to single-respondent bias. Even though the tests for common method bias did not reveal a problem in our data, exclusively surveying the opinion of leading IT architects or IT executives could lead to a rather technical perspective on the adoption of SOA, which potentially underestimates the influence of factors associated with the environmental context. Third, the particularly strong impact of IT expertise on SOA adoption could be explained in part by the fact that both are bidirectionally linked with each other. This means, of course, that a high level of IT expertise is important for implementing SOA, but an SOA project also raises the IT staff's expertise. Finally, we are aware that our paper exhibits a rather broad approach by testing the role of a variety of determinants on SOA adoption. While this is in the tradition of TOE-based studies, potential for further SOA-related findings as well as for theory-building pieces lies just below the surface. One example would be a study of the interplay between management fashion and fad in an innovation-adoption context.

6 Contributions and Future Research

We have seen that organizations follow five different approaches or stages to SOA adoption (from no adoption to a holistic SOA approach) addressing different dimensions (i.e., service-oriented business architecture, service-oriented IS architecture, service-oriented technology architecture, and fit of service-oriented architectures). SOA adoption is based predominantly on organizational prerequisites such as IT employees' IT expertise, top management support, and the compatibility

[19] Table 7 reveals much higher group means identified in the cluster analysis for management fad than for management fashion.

of SOA with an organization's IT setting. Further determinants are relative advantage, costs, organization size, and management fad. Notably, the complexity of implementing SOA is seen as a cost driver but not as an inhibitor.

This paper offers four main contributions to the research:

One, as we could find no comprehensive concept for measuring SOA adoption in the literature, we developed a multidimensional holistic research concept for SOA that is based on well-established enterprise architecture frameworks covering the business, IS and technology architectures as well as the fit between these three architectures. As the four dimensions are supported by the results of an exploratory factor analysis and as all weights of the formative indicators of the multidimensional holistic SOA adoption construct are substantial (between .36 and .52) and significant, the usefulness and applicability of all SOA dimensions is highly supported by the empirical data. Based on this concept, our paper further provides a holistic multidimensional SOA adoption measurement instrument successfully applied in quantitative research, which may be adopted, used, and improved in further empirical SOA studies.

Two, the results of the cluster analysis identified five different approaches to SOA adoption (from no adoption to a holistic SOA approach) associated with the different dimensions of the multidimensional SOA adoption measurement instrument. Identifying these five SOA adoption patterns increases our understanding of how the enterprise architecture of organizations is moving towards a service orientation. While about one-fourth of the organizations investigated have not adopted SOA at all, another 23 percent has thus far limited their service-oriented activities to the business architecture, while 18 percent have reached a medium degree among all SOA dimensions. The last third (Clusters 4 and 5) has reached a comparably higher level of comprehensive service orientation in their enterprise architecture.

Three, the results extend our knowledge of why firms adopt SOA and what they need to achieve a high degree of SOA adoption. Theoretically adapting the TOE framework to SOA adoption, our empirically evaluated SOA adoption model contributes to the literature on both SOA and organizational adoption of IT-related innovations.

Four, the comprehensive review of 38 studies applying the TOE framework (see Appendix) gives an overview of the different factors used as well as their significance in past empirical studies. The summary of previous TOE research can guide other researchers investigating the adoption of IT-related innovations at the organizational level. Further, the review reveals that our study is the first application of the TOE framework to an IT architecture context.

When applying the TOE framework, we did not rely only on the most mature factors of the technological and organizational context, but also added new factors to the environmental context (i.e., management fashion and fad) that are more applicable to this type of "innovation." The influence of fashion versus fad on the adoption of complex innovations in particular is an interesting outcome and promises to be a complementary lens for organizational adoption research.

There are several implications for practitioners. If an organization decides to adopt SOA, educating IT employees to have the necessary IT expertise for implementing SOA and convincing top management, which in turn should support the SOA initiative, are critical organizational safeguards before SOA is rolled out. Moreover, the compatibility of SOA with the existing organizational IT setting of the firm's business processes needs to be evaluated. Otherwise, the degree of

SOA adoption will remain on a comparably low level and SOA will not be woven sufficiently into the business process operations to deliver its value.

Overall, the research model we developed can be seen as a first step toward a more precise and comprehensive understanding of the factors that influence SOA adoption, the interplay between these factors, and how they should be conceptualized and measured.

Future research should investigate the *initiation of implementing SOA* as alternative dependent variable and the factors influencing it to distinguish the importance of the different TOE determinants for SOA initiation in contrast to the actual degree of SOA adoption. For example, our data show that relative advantage ($\beta = .458$; $p \leq .01$), costs ($\beta = -.154$; $p \leq .01$), top management support ($\beta = .262$; $p \leq .01$) and management fad ($\beta = .150$; $p \leq .01$) are more significant and important for SOA initiation than for actual adoption. At the same time, IT expertise is less significant ($\beta = .159$; $p \leq .05$) and compatibility ($\beta = .020$; $p > .10$) and organization size ($\beta = -.008$; $p > .10$) are not at all significant and thus do not drive the *decision* to implement SOA. Thus, one could separate the roles of the TOE determinants as drivers of SOA initiation versus enablers of actual organizational SOA adoption. This would increase the explanatory power of the model with respect to the different aspects of the adoption process and probably show even more the value of the proposed multidimensional holistic SOA research concept. In this way, more practical guidelines for managers regarding important drivers and inhibitors of SOA adoption could be derived. This would support managers in their SOA evaluation and implementation process so they do not overlook critical factors in the beginning that will be important for the implementation that follows.

7 References

Abrahamson, E. 1991. "Managerial fads and fashions: The diffusion and rejection of innovations", *Academy of Management Review* (16:3), pp. 586–612.

Armstrong, J.S. and Overton, T.S. 1977. "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research* (14:3), pp. 396–402.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Bieberstein, N., Bose, S., Fiammante, M., Jones, K., and Shah, R. 2005a. *Service-oriented architecture (SOA) compass: Business value, planning, and enterprise roadmap*. Upper Saddle River, NJ: IBM Press.

Bieberstein, N., Bose, S., Walker, L., and Lynch, A. 2005b. "Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals", *IBM Systems Journal* (44:4), pp. 691–708.

Brahe, S. 2007. "BPM on top of SOA: Experiences from the financial industry", in: *Business process management,* P.D.G. Alonso and M. Rosemann (eds.). Heidelberg: Springer, pp. 96–111.

Brown, R.H. and Karamouzis, F. 2001. "The services value chain: Forging the links of services and sourcing", *Gartner Research*.

Cenfetelli, R.T. and Bassellier, G. 2009. "Interpretation of formative measurement in information systems research", *MIS Quarterly* (33:4), pp. 689–707.

Chau, P.Y.K. and Tam, K.Y. 1997. "Factors affecting the adoption of open systems: An exploratory study", *MIS Quarterly* (21:1), pp. 1–24.

Chin, W.W. 1998. "The partial least square approach to structural equation modeling", in: *Modern methods for business research,* G.A. Marcoulides (ed.). Mahwah, NJ, USA: Lawrence Erlbaum Associates, pp. 295–336.

Choi, J., Nazareth, D.L., and Jain, H.K. 2010. "Implementing service-oriented architecture in organizations", *Journal of Management Information Systems* (26:4), pp. 253–286.

Ciganek, A.P., Haines, M.N., and Haseman, W.D. 2005. "Challenges of adopting web services: Experiences from the financial industry", in: *Proceedings of the 38th Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society.

Ciganek, A.P., Haines, M.N., and Haseman, W.D. 2009. "Service-oriented architecture adoption: Key factors and approaches", *Journal of Information Technology Management* (XX:3), pp. 42–54.

Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*, (2nd ed.). Hillsdale: Lawrence Erlbaum Associates.

Datta, A., Dutta, K., Liang, Q., and VanderMeer, D. 2011. "SOA performance enhancement through XML fragment caching", *Information Systems Research* (Articles in Advance:September 15), pp. 1–31.

Demirkan, H. and Goul, M. 2006. "AMCIS 2006 panel summary: Towards the service oriented enterprise vision: Bridging industry and academics", *Communications of the Association for Information Systems* (18:1), pp. 546–556.

DePietro, R., Wiarda, E., and Fleischer, M. 1990. "The context for change: Organization, technology and environment", in: *The processes of technological innovation,* L.G. Tornatzky and M. Fleischer (eds.). Lexington, MA: Lexington Books, pp. 151–175.

Diamantopoulos, A. 2011. "Incorporating formative measure into covariance-based structural equation models", *MIS Quarterly* (35:2), pp. 335–A335.

Eckert, J., Bachhuber, M., Repp, N., and Steinmetz, R. 2009. "The implementation of service-oriented architectures in the german banking industry - a case study", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–8.

Erickson, J. and Siau, K. 2008. "Web services, service-oriented computing, and service-oriented architecture: Separating hype from reality", *Journal of Database Management* (19:3), pp. 42–54.

Erl, T. 2004. *Service-oriented architecture: A field guide to integrating XML and web services*. Upper Saddle River, NJ: Prentice Hall.

Fichman, R.G. 1992. "Information technology diffusion: A review of empirical research", in: *Proceedings of the 13th International Conference on Information Systems (ICIS)*. Dallas, TX, USA.

Fichman, R.G. 2004. "Going beyond the dominant paradigm for information technology innovation research: Emerging concepts and methods", *Journal of the Association for Information Systems* (5:8), pp. 314–355.

Field, A.P. 2009. *Discovering statistics using SPSS*, (3 ed.). Los Angeles: Sage Publications, Ltd.

Gartner. 2009. "Gartner's 2009 hype cycle special report evaluates maturity of 1,650 technologies". retrieved 05/03/2010, from http://www.gartner.com/it/page.jsp?id=1124212.

Gefen, D., Rigdon, E.E., and Straub, D. 2011. "An update and extension to SEM guidelines for administrative and social science research", *MIS Quarterly* (35:2), pp. iii–A7.

Gefen, D., Straub, D.W., and Boudreau, M.-C. 2000. "Structural equation modeling and regression: Guidelines for research practice", *Communications of the Association for Information Systems* (4:1), pp. 1–77.

Goode, S. and Gregor, S. 2009. "Rethinking organisational size in IS research: Meaning, measurement and redevelopment", *European Journal of Information Systems* (18:1), pp. 4–25.

The Open Group. 2009. *TOGAF version 9*, (9 ed.). Zaltbommel: Van Haren Publishing.

Heffner, R. 2010. "Adoption of SOA: Still strong, even in hard times", *Forrester Research*.

Hirschheim, R., Welke, R., and Schwarz, A. 2010. "Service-oriented architecture: Myths, realities, and a maturity model", *MIS Quarterly Executive* (9:1), pp. 37–48.

Ifinedo, P. 2011a. "An empirical analysis of factors influencing internet/e-business technologies adoption by SMEs in Canada", *International Journal of Information Technology & Decision Making* (10:4), pp. 731–766.

Ifinedo, P. 2011b. "Internet/e-business technologies acceptance in Canada's SMEs: An exploratory investigation", *Internet Research* (21:3), pp. 255–281.

Janssen, M. and Joha, A. 2008. "Emerging shared service organizations and the service-oriented enterprise: Critical management issues", *Strategic Outsourcing: An International Journal* (1:1), pp. 35–49.

Jeyaraj, A., Rottman, J.W., and Lacity, M.C. 2006a. "A review of the predictors, linkages, and biases in IT innovation adoption research", *Journal of Information Technology* (21:1), pp. 1–23.

Jeyaraj, A., Rottman, J.W., and Lacity, M.C. 2006b. "A review of the predictors, linkages, and biases in IT innovation adoption research; online appendix after request from the third author", *Journal of Information Technology* (21:1), pp. 1–23.

Joachim, N. 2009. "Service-oriented architectures (SOA): An empirical investigation of adoption determinants and resulting business value", in: *Doctoral consortium of the 30th International Conference on Information Systems (ICIS)*. Phoenix, AZ, USA.

Joachim, N. 2011. "A literature review of research on service-oriented architectures (SOA): Characteristics, adoption determinants, governance mechanisms, and business impact", in: *Proceedings of the 17th Americas Conference on Information Systems (AMCIS)*. Detroit, MI, USA.

Joachim, N., Beimborn, D., Hoberg, P., and Schlosser, F. 2009. "Examining the organizational decision to adopt service-oriented architecture (SOA) – development of a research model", in: *Proceedings of the Special Interest Group on Adoption and Diffusion of Information Technology (DIGIT) (Pre-ICIS Workshop)*. Phoenix, AZ, USA.

Joachim, N., Beimborn, D., Schlosser, F., and Weitzel, T. 2011. "Does SOA create or require IT/business collaboration? Investigating SOA's potential to reduce the gap between IT and business", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*. Shanghai, China.

Joachim, N., Beimborn, D., and Weitzel, T. 2010a. "Investigating adoption determinants of service-oriented architectures (SOA)", in: *Proceedings of the Special Interest Group on Services (SIG SVC) (Pre-ICIS Workshop)*. St. Louis, MO, USA.

Joachim, N., Beimborn, D., and Weitzel, T. 2010b. "Why do firms adopt service-oriented architectures? A conceptualization and evaluation of SOA adoption", in: *MIS Quarterly Prospective Authors (Pre-ICIS) Workshop*. St. Louis, MO, USA.

Krafzig, D., Banke, K., and Slama, D. 2005. *Enterprise SOA: Service-oriented architecture best practices*. Upper Saddle River, NJ: Prentice Hall.

Kristensen, K. and Eskildsen, J. 2010. "Design of PLS-based satisfaction studies", in: *Handbook of partial least squares: Concepts, methods and applications,* V.E. Vinzi, W.W. Chin, J. Henseler, and H. Wang (eds.). Heidelberg: Springer, pp. 247–277.

Kuan, K.K.Y. and Chau, P.Y.K. 2001. "A perception-based model for EDI adoption in small businesses using a technology-organization-environment framework", *Information & Management* (38:8), pp. 507–521.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007. "SOA and information sharing in supply chain: “How” information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Lederer, A.L. and Mendelow, A.L. 1988. "Convincing top management of the strategic potential of information systems", *MIS Quarterly* (12:4), pp. 525–534.

Lewis, B.R., Snyder, C.A., and Rainer, R.K. 1995. "An empirical assessment of the information resource management construct", *Journal of Management Information Systems* (12:1), pp. 199–223.

Lindell, M.K. and Whitney, D.J. 2001. "Accounting for common method variance in cross-sectional research designs", *Journal of Applied Psychology* (86:1), pp. 114–121.

Löhe, J. and Legner, C. 2010. "SOA adoption in business networks: Do service-oriented architectures really advance inter-organizational integration?", *Electronic Markets* (20:3), pp. 181–196.

Lublinsky, B. 2007. "Defining SOA as an architectural style: Align your business model with technology". retrieved 08/11/2010, from http://www.ibm.com/developerworks/architecture/library/ar-soastyle/.

Malhotra, A., Gosain, S., and El Sawy, O.A. 2005. "Absorptive capacity configurations in supply chains: Gearing for partner-enabled market knowledge creation", *MIS Quarterly* (29:1), pp. 145–187.

Meschke, M. and Baumoel, U. 2010. "Architecture concepts for value networks in the service industry", in: *Proceedings of the 31st International Conference on Information Systems (ICIS)*. St. Louis, MI, USA, pp. 1–13.

Mishra, A.N., Konana, P., and Barua, A. 2007. "Antecedents and consequences of internet use in procurement: An empirical investigation of U.S. manufacturing firms", *Information Systems Research* (18:1), pp. 103–120.

Nunnally, J.C. 1978. *Psychometric theory*, (2. ed.). New York, NY: McGraw-Hill.

Oh, L.-B., Leong, Y.-X., Teo, H.-H., and Ravichandran, T. 2007. "Service-oriented architecture and organizational integration: An empirical study of IT-enabled sustained competitive advantage", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Oliveira, T. and Martins, M.F. 2011. "Literature review of information technology adoption models at firm level", *The Electronic Journal Information Systems Evaluation* (14:1), pp. 110–121.

Papazoglou, M.P. and Heuvel, W.-J. 2007. "Service oriented architectures: Approaches, technologies and research issues", *The VLDB Journal* (16:3), pp. 389–415.

Pavlou, P.A. and Sawy, O.A.E. 2010. "The "third hand": IT-enabled competitive advantage in turbulence through improvisational capabilities", *Information Systems Research* (21:3), pp. 443–471.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. 2003. "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Psychology* (88:5), pp. 879–903.

Prescott, M.B. and Conger, S.A. 1995. "Information technology innovations: A classification by IT locus of impact and research approach", *DATA BASE* (26:2-3), pp. 20–41.

Rai, A., Tang, X.L., Brown, P., and Keil, M. 2006. "Assimilation patterns in the use of electronic procurement innovations: A cluster analysis", *Information & Management* (43:3), pp. 336–343.

Ren, M. and Lyytinen, K.J. 2008. "Building enterprise architecture agility and sustenance with SOA", *Communications of the Association for Information Systems* (22:1), pp. 75–86.

Ringle, C.M., Wende, S., and Will, A. 2007. "SmartPLS 2.0 (M3) Beta". Hamburg.

Robey, D., Im, G., and Wareham, J.D. 2008. "Theoretical foundations of empirical research on interorganizational systems: Assessing past contributions and guiding future directions", *Journal of the Association for Information Systems* (9:9), pp. 497–518.

Rogers, E.M. 2003. *Diffusion of innovations*, (5. ed.). New York, NY: Free Press.

Schelp, J. and Aier, S. 2009. "SOA and EA – sustainable contributions for increasing corporate agility", in: *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA.

Sharma, S. 2008. *Applied multivariate techniques*, (15 ed.). New York, NY: Wiley.

Siedersleben, J. 2007. "SOA revisited: Component orientation in system landscapes", *Wirtschaftsinformatik* (49:Special Issue), pp. 110–117.

Tafti, A., Mithas, S., and Krishnan, M.S. 2008. "The effects of information technology and service-oriented architectures on joint venture value", in: *Proceedings of the 29th International Conference on Information Systems (ICIS)*. Paris, France.

Tewary, A.K., Kosalge, P., and Motwani, J. 2009. "Piloting service oriented architecture—a case study in the oil industry", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–12.

Thong, J.Y.L. 1999. "An integrated model of information systems adoption in small businesses", *Journal of Management Information Systems* (15:4), pp. 187–214.

Tiwana, A. and Konsynski, B. 2010. "Complementarities between organizational IT architecture and governance structure", *Information Systems Research* (21:2), pp. 288–304.

Tornatzky, L.G. and Fleischer, M. (eds.). 1990. *The processes of technological innovation*. Lexington, MA: Lexington Books.

Tornatzky, L.G. and Klein, K.J. 1982. "Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings", *IEEE Transactions on Engineering Management* (36:1), pp. 28–43.

Viering, G., Legner, C., and Ahlemann, F. 2009. "The (lacking) business perspective on SOA - critical themes in SOA research", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 45–54.

Vitharana, P., Bhaskaran, K., Jain, H., Wang, H.J., and Zhao, J.L. 2007. "Service-oriented enterprises and architectures: State of the art and research opportunities", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA.

Winter, R. and Fischer, R. 2007. "Essential layers, artifacts, and dependencies of enterprise architecture", *Journal of Enterprise Architecture* (3:2), pp. 1–12.

Wolfe, R.A. 1994. "Organizational innovation: Review, critique and suggested research directions", *Journal of Management Studies* (31:3), pp. 405–431.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

Zhao, J.L., Goul, M., Purao, S., Vitharana, P., and Wang, H.J. 2008. "Impact of service-centric computing on business and education", *Communications of the Association for Information Systems* (22:16), pp. 295–310.

Zhu, K. and Kraemer, K.L. 2005. "Post-adoption variations in usage and value of e-business by organizations: Cross-country evidence from the retail industry", *Information Systems Research* (16:1), pp. 61–84.

Zhu, K., Kraemer, K.L., and Sean Xu, K. 2003. "Electronic business adoption by european firms: A cross-country assessment of the facilitators and inhibitors", *European Journal of Information Systems* (12:4), pp. 251–268.

8 Appendix

Construct	Item		Scale
Relative advantage (IT) *(formative)*	RAI1 RAI2 RAI3	To what degree do you associate the following advantages with SOA? • Reducing costs for developing and adapting applications • Reducing costs for running the IT and IT management • Reducing redundant implementations	5-Likert scale from no advantage to big advantage
Relative advantage (business) *(formative)*	RAB1 RAB2 RAB3	To what degree do you associate the following advantages with SOA? • Faster and more effective reactions of IT with respect to business' needs • Higher degree of automation within business processes • Increasing data quality/ timeliness/ consistency	
Compatibility *(formative)*	COB1-5	To what extent are the following business processes supported by IT? (1) production/operations; (2) procurement/B2B integration; (3) R&D; (4) marketing/sales/customer relations; (5) support processes (F&A, HR etc.) *The 5 items were combined to a single factor using factor analysis.*	5-Likert scale from no IT to completely supported by IT
Costs	COS1	Implementing SOA in our organization requires considerable human resources.	5-Likert scale from completely disagree to fully agree
	COS2	For adopting SOA substantial changes to our organization and decision structures have to be made.	
	COS3	Implementing SOA demands high training efforts.	
Complexity	COX1	Identifying business service candidates in our business processes is difficult.	
	COX2	Application functionality is difficult to encapsulate into modular services.	
Organization size	OSI	Logarithm of total number of employees.	source: secondary data
Top management support	TMS1	Top management supports the implementation of SOA.	5-Likert scale from completely disagree to fully agree
	TMS2	Top management provides the necessary resources for the introduction of SOA.	
	TMS3	Top management takes possible risks, which may result from introducing SOA.	
IT expertise	EXP1	Our IT is able to quickly comprehend the principles of service orientation.	
	EXP2	Our IT has the necessary experience for implementing SOA.	
	EXP3	Our IT possesses comprehensive knowledge about the SOA concept.	
Management fad	FAD1	Many of our competitors have already implemented SOA.	
	FAD2	Many of our business partners have already implemented SOA.	
Management fashion	FAS1	SOA has a dominant role in specialized journals.	
	FAS2	SOA is marketed as panacea or silver bullet by consultants and IT firms.	
Competition	COM1	Our organization faces very intense competition.	
	COM2	The life cycle of products/ services is very short in our industry.	
Controls:			
IT budget	ITB	Size of firm's IT budget (scale: < 10 mill. €, 10-100 mill. €, 100-250 mill. €, 250-500 mill. €, 500-1000 mill. €)	
Years employed	YEO	Years the respondent has worked for the surveyed organization.	
Industry type	INT	Industry sector: financial services, trade & logistics, ICT, other services (secondary data)	

Table 5. Items and scales of TOE determinants and control variables

Construct	Item		Scale
Service-orientated business architecture	SOB1	We follow a service-oriented perspective when modeling business activities.	5-Likert scale from completely disagree to fully agree
	SOB2	Services are the primary concept for structuring the non-technical level.	
Service-oriented IS architecture	SOI1	Our firm has realized its IT architecture in an SOA-oriented manner.	7-Likert scale from completely disagree to fully agree
	SOI2	Our IT landscape follows the SOA paradigm as far as possible.	
	SOI3	Service orientation is the primary design principle of our IT architecture.	
	SOI4	All of our applications are integrated via service-oriented interfaces.	
Service-oriented technology architecture		To which extent are the following technologies used in your organization?	0 = {not known | not applied}; 1 = pilot usage; 2 = single projects; 3 = particular business area; 4 = multiple business areas; 5 = firm wide
	SOT1	XML	
	SOT2	Web Services (WSDL, SOAP)	
	SOT3	Enterprise service bus (ESB) or other service-related bus	
	SOT4	Registry / repository	
	SOT5	Business process execution language (BPEL)	
Fit of service-oriented architectures		To which extent are the following processes supported by SOA?	5-Likert scale from "no SOA" to "completely supported by SOA"
	FSA1	production/operations	
	FSA2	procurement/B2B integration	
	FSA3	research & development	
	FSA4	marketing/sales/customer relations	
	FSA5	support processes (F&A, HR etc.)	

Table 6. Operationalization of the SOA adoption research construct

Factor / Item	Service-oriented business architecture	Service-oriented IS architecture	Service-oriented technology architecture (1)	Service-oriented technology architecture (2)	Fit of service-oriented architectures
SOB1	**.902**	.264	.040	.076	.153
SOB2	**.883**	.267	.087	.147	.153
SOI1	.122	**.848**	.149	.170	.312
SOI2	.187	**.859**	.095	.189	.292
SOI3	.279	**.791**	.104	.162	.288
SOI4	.220	**.796**	.145	.036	.253
SOT1	.005	.136	**.878**	-.011	.104
SOT2	.141	.237	**.686**	.331	.231
SOT3	.094	-.022	.415	**.599**	.188
SOT4	.134	.118	.073	**.732**	.158
SOT5	.015	.221	-.021	**.760**	.126
FSA1	.169	.280	.103	.257	**.741**
FSA2	.093	.227	.121	.115	**.844**
FSA3	.055	.204	.052	.184	**.759**
FSA4	.108	.324	.253	.144	**.760**
FSA5	.112	.175	.071	.047	**.832**
Eigenvalue	1.386	1.627	.978	1.088	7.156
Percentage of Variance	8.66%	10.17%	6.11%	6.80%	44.73%
Note: All factor loadings ≥ .45 are highlighted in bold.					

Table 7. Results of the exploratory factor analysis for the SOA adoption research construct

Factor	Exemplary Quote	Source
Technological context		
Relative advantage	"Benefits that organizations experience from SOA implementation can be divided into two sub-categories: improved business agility and lowered costs. […] The subcategory 'improved business agility' consists of quick IT responses to the business environment, market changes or customer demands, easier-to-integrate systems, better alignment of IT with the business, better data flow, and better customer service. […] The sub-category 'lowered costs' consists of lower application development costs/time, reusability of existing functions, lower maintenance costs, and lower operational costs." (Yoon and Carter 2007, p. 7)	Yoon and Carter (2007), Ciganek et al. (2009), Tewary et al. (2009), Choi et al. (2010)
Compatibility	"The typical IT structure is so dense and extensive […] making it difficult for an organization and its processes to be flexible and agile. […] Large organizations like Airbus industries (Blau, 2006) are increasingly approaching Service oriented architecture (SOA) to overcome this problem." (Tewary et al. 2009, p. 1)	Yoon and Carter (2007), Eckert et al. (2009), Tewary et al. (2009), Choi et al. (2010)
Complexity	"Decoupling the systems has led to increased complexity, but the systems are more flexible and integration is easier now." (Schelp and Aier 2009, p. 6)	Schelp and Aier (2009), Tewary et al. (2009), Choi et al. (2010)
Costs	"For managers seeking to adopt SOA, greater insight is sorely needed, given that the investment is nontrivial and entails significant retraining of existing IS personnel and, possibly, new recruitment." (Choi et al. 2010, p. 270)	Yoon and Carter (2007), Tewary et al. (2009), Choi et al. (2010)
Organizational context		
Organization size	"Large organizations are characterized by an extremely complex network of enterprise applications, each based on different application architectures: a heterogeneous composition of solutions that do not easily communicate with each other." (Tewary et al. 2009, p. 1)	Tewary et al. (2009), Choi et al. (2010)
IT expertise	"Bishop noted, "We've had to educate people about what's already built, get them thinking about how they build in a componentized environment, how to reuse, how to deploy, and how to make it." (Yoon and Carter 2007, p. 7)	Yoon and Carter (2007), Tewary et al. (2009)
Top management support	"The 'CEO strongly supported building end-to-end, service-oriented development and delivery platform,' said Wachovia's Susan Certoma." (Yoon and Carter 2007, p. 7)	Yoon and Carter (2007), Ciganek et al. (2009), Eckert et al. (2009)
Environmental context		
Management fashion	"Driven by vendors, analysts, and consultants the expectation is arising (again) that the introduction of this technology [(SOA)] leads to a better adaptation of corporate IS to changing business processes and to a better business process support in general." (Schelp and Aier 2009, p. 1)	Schelp and Aier (2009)
Management fad	"Reported SOA success stories among peers and competitors are frequent justifications for whether adoption of the technology is a good fit for an organization." (Choi et al. 2010, p. 255)	Choi et al. (2010)
Competition	"These market dynamics give rise to a need for business flexibility in order to cope with continual change and get ahead of the competition. To achieve business agility, organizations require a flexible information technology (IT) architecture that supports dynamic change in response to customer preference, technological innovation, and competitive landscape. Many companies are moving to a Service-Oriented Architecture (SOA) as a means to attain IT architecture flexibility." (Yoon and Carter 2007, p. 1)	Yoon and Carter (2007), Tewary et al. (2009), Choi et al. (2010)

Table 8. Support from SOA literature regarding factors influencing SOA adoption based on Joachim (2011)

Construct	Indicator	Mean	SD	Skewness	Curtosis	Loadings (*Weights*)
Relative advantage (IT)	RAI1	.116	1.047	-.340	-.732	(*.058*)
	RAI2	-.214	1.010	.018	-.612	(*.385***)
	RAI3	.422	1.089	-.689	-.120	(*.731***)
Relative advantage (business)	RAB1	.416	1.033	-.581	-.217	(*.655***)
	RAB2	.474	1.080	-.469	-.472	(*.344**)
	RAB3	.331	1.115	-.342	-.706	(*.214*$^{+}$)
Compatibility	COB1-5	.000	1.000	-.413	.143	1.000
Costs	COS1	.944	.954	-.702	.071	.848**
	COS2	.722	1.005	-.471	-.492	.761**
	COS3	.766	.891	-.418	-.220	.768**
Complexity	COX1	.404	.926	.012	-.642	.755**
	COX2	.146	1.051	.138	-.743	.873**
Organization size	OSI	3.345	.584	1.140	2.055	1.000
Top management support	TMS1	-.229	1.285	.265	-.892	.918**
	TMS2	-.567	1.122	.542	-.266	.927**
	TMS3	-.646	1.112	.375	-.673	.907**
IT expertise	EXP1	.091	1.006	-.262	-.381	.833**
	EXP2	-.584	1.192	.414	-.858	.944**
	EXP3	-.597	1.112	.451	-.569	.921**
Management fad	FAD1	.108	1.050	-.151	-.630	.905**
	FAD2	.628	1.096	-.574	-.403	.774**
Management fashion	FAS1	-.933	.861	.492	-.356	.924**
	FAS2	-.910	.776	.351	-.219	.947**
Competition	COM1	1.117	1.060	-1.371	1.524	.741**
	COM2	-.477	1.144	.460	-.597	.839**
SOA adoption	SOB1-2	.000	1.000	.064	-.773	(*.389***)
	SOI1-4	.000	1.000	.431	-.656	(*.423***)
	SOT1-2	.000	1.000	.019	.257	(*.363***)
	SOT3-5	.000	1.000	1.603	3.599	(*.523***)
	FSA1-5	.000	1.000	1.010	.571	(*.515***)
IT budget	ITB	-1.449	.874	1.868	4.147	1.000
Years employed	YEO	11.210	7.510	.507	-.219	1.000
Industry type	INT	1.084	1.041	.287	-1.329	1.000
Note: The last column contains loadings and weights. The latter ones are highlighted in italic. **: $p \leq .01$; *: $p \leq .05$; $^{+}$: $p \leq .1$						

Table 9. Statistical properties of the indicator variables

	C. R.	AVE	1	2	3	4	5	6	7	8	9
1 - Compatibility	1.000	1.000	1.000								
2 - Costs	.836	.630	-.039	.793							
3 - Complexity	.799	.666	-.111	.148	.816						
4 - Organization size	1.000	1.000	.017	-.137	-.105	1.000					
5 - Top mgmt. support	.941	.841	.193	-.250	-.275	.157	.917				
6 - IT expertise	.928	.811	.116	-.185	-.426	.233	.630	.901			
7 - Management fad	.829	.709	.105	.182	-.010	-.081	.143	.134	.842		
8 - Management fashion	.934	.876	.047	-.045	-.155	.157	.298	.357	.195	.936	
9 - Competition	.770	.627	-.032	.153	.116	.020	-.062	.020	.119	.088	.792

Table 10. Convergent validity and reliability as well as discriminant validity of model constructs (diagonal cells contain the square root of AVE)

	Compatibility	Costs	Complexity	Organization size	Top mgmt. support	IT expertise	Management fad	Management fashion	Competition
COB1-5	1.000	-.039	-.111	.017	.193	.116	.105	.047	-.032
COS1	-.004	.848	.120	-.139	-.254	-.152	.148	-.108	.159
COS2	-.051	.761	.073	-.107	-.246	-.163	.096	.066	.131
COS3	-.048	.768	.158	-.072	-.086	-.128	.187	-.038	.066
COX1	-.164	.205	.755	-.001	-.230	-.224	.054	-.072	.102
COX2	-.038	.059	.873	-.150	-.223	-.445	-.054	-.168	.091
OSI	.017	-.137	-.105	1.000	.157	.233	-.081	.157	.020
TMS1	.154	-.218	-.218	.134	.918	.597	.197	.304	-.013
TMS2	.196	-.295	-.326	.190	.927	.606	.126	.238	-.093
TMS3	.182	-.168	-.205	.103	.907	.525	.064	.278	-.066
EXP1	.044	-.128	-.333	.170	.559	.833	.194	.244	-.003
EXP2	.131	-.173	-.405	.247	.581	.944	.087	.348	.073
EXP3	.134	-.198	-.409	.209	.562	.921	.090	.366	-.022
FAD1	.099	.203	-.076	-.070	.150	.143	.905	.176	.104
FAD2	.074	.083	.092	-.067	.080	.072	.774	.153	.098
FAS1	.090	-.041	-.102	.110	.244	.309	.168	.924	.081
FAS2	.006	-.042	-.181	.178	.308	.355	.196	.947	.084
COM1	-.024	.193	.042	.012	-.050	.041	.147	-.081	.741
COM2	-.027	.063	.133	.018	-.049	-.004	.052	.192	.839

Table 11. Discriminant validity - crossloadings of reflective indicators

Literature Review on Studies Applying the TOE framework

First, we screened the TOE section on the "Theories Used in IS Research Website" (http://www.istheory.yorku.ca) using a keyword search and checking the referenced articles. We found 22 papers published between 1993 and 2007. Next we used these 22 papers, as well as five literature review articles on organizational adoption (Fichman 1992; Jeyaraj et al. 2006a; Prescott and Conger 1995; Tornatzky and Klein 1982; Wolfe 1994) and the seminal work on the TOE-framework (DePietro et al. 1990; Tornatzky and Fleischer 1990) as a starting point to search for other papers citing these publications. This forward search was done using the Social Sciences Citation Index (SSCI from 1980 to present), Science Citation Index Expanded (SCI-Expanded from 1980 to present), Conference Proceedings Citation Index Social Science & Humanities (CPCI-SSH from 1990 to present), and the Conference Proceedings Citation Index Science (CPCI-S from 1990 to present) provided by Thomson Reuters. This identified 2,083 papers citing the "seed" publications up to July 2011. We screened the title and abstract of each paper to determine whether it seemed worth checking the full text. This led to an initial list of 34 articles, to which we added two additional quantitative papers listed in a literature review on organizational adoption (Oliveira and Martins 2011) that had been identified in the previous step covering 23 papers applying the TOE framework in qualitative as well as quantitative research, and another two articles citing other papers that had appeared recently (Ifinedo 2011a; Ifinedo 2011b). In total, then, we found the 38 papers listed in Table 12 of this Appendix that applied the TOE framework in a quantitative study.

Author(s) / Dependent Variable(s)	Technological Context	Organizational Context	Environmental Context	Controls / Other Contexts
(Chwelos et al. 2001) Intention to Adopt EDI	Perceived Benefits (+)	Financial Resources (+) IT Sophistication (+) Trading Partner Readiness (+)	Competitive Pressure (+) Dependency on Trading Partner (ns) Enacted Trading Partner Power (+) Industry Pressure (ns)	
(Mishra et al. 2007) Extent of Internet Use in Search; Extent of Internet Use in Order Initiation and Completion	Procurementprocess Digitization (+,+)	Diversity of Organizational Procurement Knowledge (+,ns)	Suppliers' Sales-Process Digitization (nc,-) Organizational Perceptions of Technological Uncertainty (ns,+) Organizational Perceptions of Volume Uncertainty (+,ns)	Firm Size
(Premkumar et al. 1997) EDI Adoption	Relative Advantage (ns) Compatibility (ns) Complexity (ns) Cost (ns)	Top Management Support (+) Product Champion (ns) Size (+)	Climate (ns) Net-Dependence (ns) Competitive Pressure (+) Customer Support (+)	
(Chau and Hui 2001) EDI Adoption	Perceived Direct Benefits (+) Perceived Indirect Benefits (ns)	Prior EDI Experience (+) Perceived Support from the Vendor (+) Perceived Costs (-)	Government Influence (ns) Business Partners' Influence (-)	
(Chau and Tam 1997) Open Systems Adoption	Perceived Benefits (ns) Perceived Barriers (-) Perceived Importance of Compliance to Standards, Interoperability, and Interconnectivity (+)	Complexity of IT Infrastructure (ns) Satisfaction with Existing Systems (-) Formalization on System Development and Management (ns)	Market Uncertainty (ns)	
(Kuan and Chau 2001) EDI Adoption	Perceived Direct Benefits (+) Perceived Indirect Benefits (ns)	Perceived Financial Cost (-) Perceived Technical Competence (+)	Perceived Industry Pressure (-) Perceived Government Pressure (+)	
(Premkumar and Roberts 1999) Adoption Decision of Communication Technologies (Online Data Access, E-Mail, EDI, Internet)	Relative Advantage (+, +, +, +) Cost (ns, ns, ns, ns) Complexity (-, ns, ns, ns) Compatibility (+, ns, ns, ns)	Top Management Support (+, +, ns, ns) Size (+, +, +, ns) IT Expertise (ns, +, ns, ns)	Competitive Pressure (+, +, ns, ns) External Pressure (+, +, ns, ns) External Support (ns, ns, -, ns) Vertical Linkages (+, ns, ns, ns)	
(Zhu and Kraemer 2005) E-Business Use	Technology Competence (+)	Size (-) International Scope (ns) Financial Commitment (+)	Competitive Pressure (+) Regulatory Support (+)	
(Zhu et al. 2003) Intent to Adopt E-Business	Technology Competence (+)	Firm Scope (+) Firm Size (+)	Consumer Readiness (+) Competitive Pressure (+) Lack of Trading Partner Readiness (-)	Industry Effect Country Effect

Author(s) / Dependent Variable(s)	Technological Context	Organizational Context	Environmental Context	Controls / Other Contexts
(Zhu et al. 2006b) E-Business (Initiation, Adoption, Routinization)	Technology Readiness (+, +, +) Technology Integration (+, +, +)	Firm Size (ns, -, -) Global Scope (ns, ns, ns) Managerial Obstacles (-, ns, -)	Competition Intensity (+, +, -) Regulatory Environment (+, ns, +)	
(Thong 1999) Likelihood of IS Adoption, Extent of IS Adoption	Relative Advantage/ Compatibility of IS (+, ns) Complexity of IS (+, ns)	Business Size (+, +) Employees' IS Knowledge (+, +) Information Intensity (ns, +)	Competition (ns, ns)	CEO Characteristics: CEO's Innovativeness (+, ns) CEO's IS Knowledge (+, ns)
(Zhu et al. 2006a) E-Business Usage	Relative Advantage (+) Compatibility (+) Costs (-) Security Concern (-)	Technology Competence (+) Organization Size (-)	Competitive Pressure (+) Partner Readiness (+)	
(Berger and Martin 2008) Customer Lifetime Value Metric Adoption	Perceived Usefulness (+) Perceived Ease of Use (+)	Firm Size (ns) Firm Profitability (-) Perceived Importance of Customer Management (ns)	Competitive Pressure (+)	
(Chang et al. 2007) Adoption of E-Signature	Security Protection (ns) System Complexity (ns)	User Involvement (ns) Adequate Resources (+) Hospital Size (+) Internal Need (ns)	Vendor Support (-) Government Policy (+)	
(Hsu et al. 2006) E-business Use (Diversity, Volume)	Perceived Benefits (+, +)	Firm Size (+, +) Technology Resources (+, ns) Globalization Level (+, +)	Trading Partners Pressure (+, ns) Government Pressure (ns, +) Regulatory Concern (ns, ns) Competition Intensity (-, ns)	Industry: Manufacturing (-,-) Finance (ns, ns)
(Huang et al. 2008) Internet-EDI Adoption	Relative Advantage (+) Compatibility (ns) Complexity (-)	Strategic Use of CT (+) Trust in Technology (+) Application Knowledge (+) Top Management Support (+) Organizational Size (ns) Organizational Slack (+)	Competitive Pressure (+) Network Externality (ns)	Interorganizational Determinants: Dependency on Partner (ns) Potential Power (+) Exercised Power (ns) Trust in Partner (+) Relationship Commitment (+)
(Li 2008) E-procurement Adoption Decision	Relative Advantage (+) Complexity (ns) Compatibility (ns)	Financial Slacks (ns) Top Management Support (+) Technological Readiness (ns)	External Pressure (+) External Support (+) Government Promotion (ns)	

Author(s) / Dependent Variable(s)	Technological Context	Organizational Context	Environmental Context	Controls / Other Contexts
(Pan and Jang 2008) ERP Adoption	IT Infrastructure (ns) Technology Readiness (+)	Size (+) Perceived Barriers (-)	Production and Operations Improvement (+) Enhancement of Products and Services (ns) Competitive Pressure (ns) Regulatory Policy (ns)	
(Soares-Aguiar and Palma-Dos-Reis 2008) E-Procurement Adoption	IT Infrastructure (+) IT Expertise (+) B2B Know how (+)	Firm Scope(ns) Firm Size (+)	Extent of Adoption Among Competitors (+) Trading Partner Readiness (+) Perceived Success of Competitive Adopters (+)	Industry: Manufacturing (ns) Commerce Area (+)
(Teo et al. 2007) Decision to Adopt HRIS, Extent of HRIS Adoption (HRM Functions), Extent of HRIS Adoption (Number of HRIS Applications)	Departmental Relative Advantage (+, ns, ns) Organizational Relative Advantage (+, ns, ns) Complexity (ns, ns, ns) Compatibility (+, ns, ns)	Top Management Support (+, ns, +) Size (+, +, +) HRIS Expertise (+, ns, ns)	Competition (ns, +, ns)	
(Teo et al. 2009) E-Procurement Adoption	Perceived Direct Benefits (ns) Perceived Indirect Benefits (+) Perceived Costs (ns)	Firm Size (+) Top Management Support (+) Information Sharing Culture (ns)	Business Partner Influence (+)	Industry Type (ns)
(Li et al. 2009) E-Business Assimilation	Relative Advantage (+) IT Capability (+)	Ownership Type (+) Learning Orientation (+)	Environmental Uncertainty (-) Inter-organizational Dependence (+)	Firm Size (+) Business Type (+) Firm Age (ns) Web Experience (+)
(Mohamed et al. 2009) Web Technology Investment	Technology Competence (ns)	Firm Size (+) Managerial Beliefs (+)	Pressure Intensity (+)	
(Molla et al. 2010) E-Business Use	Technology Competence (+)	Size (-) Financial Commitment (+) Perceived Organizational E-Readiness (ns)	Perceived Environmental E-Readiness (+)	
(Lin and Ho 2009) RFID Adoption	Explicitness (+) Accumulation (+)	Encouragement for Innovation (+) Quality of Human Resources (+)	Environmental Uncertainty (ns) Governmental Support (+)	Company History (ns) Number of Employee (ns) Capital Size (ns) Bar Code Experience (+)

Author(s) / Dependent Variable(s)	Technological Context	Organizational Context	Environmental Context	Controls / Other Contexts
(Liu 2011) Intention of Telecare Adoption	Compatibility (+) Relative Advantage (ns) Supplier Support (+)	Top Management Support (ns) Technological Knowledge (+) Internal Need (ns)	Government Support (+) Business Competition Pressure (ns)	Project Planning Context: Team Skills (+) Resources (ns) User Participation (ns)
(Oliveira and Martins 2010) E-Business Adoption	Perceived Benefits and Obstacles of E-Business (+)	Technology Readiness (+) Technology Integration (+) Firm Size (ns)	Competitive Pressure (+) Trading Partner Collaboration (+)	Country Industry
(Rodriguez-Ardura and Meseguer-Artola 2010) E-Commerce Adoption		Non-Technological Internal Context: Firm's Global Scope (+) Technological Internal Context: Firm's Competence in Technological Innovation (+)	Non-Technological External Context: Pressure From Firms (-) Enrichment of Consumer Behavior Patterns (+) Technological External Context: Technological Readiness of Market Forces (+)	
(Wang et al. 2010) RFID Adoption	Relative Advantage (ns) Complexity (-) Compatibility (+)	Top Management Support (ns) Firm Size (+) Technology Competence (ns)	Competitive Pressure (+) Trading Partner Pressure (+) Information Intensity (-)	
(Oliveira and Martins 2009) Web Site Adoption E-commerce Adoption	Technology Readiness (+, ns) Technology Integration (ns, +) Security Applications (+, ns)	Firm Size (+, ns) Perceived Benefits of Electronic Correspondence (+, +) IT Training Programs (+, ns) Access to the IT System of the Firm (+, +) Internet and E-Mail Norms (+, ns) Main Perceived Obstacle (nc, -)	Web Site Competitive Pressure (+, nc) E-commerce Competitive Pressure (nc, +)	Type of Industry
(Liu 2008) E-Commerce Development Level	E-Commerce Foundation (+) Potential Support from Technology (+)	Management Level for Informatization (+) Firm Size (ns)	User Satisfaction (+) EC Security (+)	Firm Property (ns)
(Gibbs and Kraemer 2004) Scope of E-Commerce Use	Technology Resources (+)	Perceived Benefits (+) Lack of Organizational Compatibility (ns) Financial Resources (+) Firm Size (ns)	External Pressure (+) Government Promotion (+) Legislation Barriers (-)	Country (-) Industry (ns)

Author(s) / Dependent Variable(s)	Technological Context	Organizational Context	Environmental Context	Controls / Other Contexts
(Teo et al. 2006) Deployment of B2B E-Commerce	Lack of Interoperability (ns) Lack of IT Expertise and Infrastructure (-) Unresolved Technical Issues (-)	Difficulties in Organizational Change (ns) Problems in Project Management (-) Difficulties in Cost-Benefit Assessment (-) Lack of E-Commerce Strategy (-) Lack of Top Management Support (-)	Unresolved Legal Issues (ns) Fear and Uncertainty (ns)	
(Lee and Kim 2007) Internet-Based Information Systems (IIS) Implementation (Volume, Sophistication, Information Contents)	Compatibility (+, +, ns) Relative Advantage (ns, ns, ns) Complexity (ns, ns, ns)	Customer Interaction (-, ns, ns) Top Management Support (ns, ns, +)		IS Related Factors: IS Infrastructure (ns, +, +) IS Expertise (+, ns, ns) Importance of IS Security (ns, +, +)
(Xu et al. 2004) Incentive to Adopt E-Business	Technology Competence (+)	Firm Size (ns) Global Scope (ns) Enterprise Integration (+)	Competition Intensity (+) Regulatory Environment (+)	
(Cui et al. 2008) IT Usage	IT Infrastructure (+)	IT Management (+)	Government Actions & Policies (ns)	
(Ifinedo 2011a) Internet and E-Business Technologies Adoption	Relative Advantage (+) Compatibility (ns) Complexity (ns)	Management Support (+) Organizational Readiness (ns)	Competition's Pressure (+) Customer's Pressure (ns) Partner's Pressure (ns) Government Support (ns)	Firm Size: Revenue (ns) Firm Size: Workforce (ns) Industry Sector (ns) Firm Age (ns)
(Ifinedo 2011b) Internet and E-Business Technologies Adoption	Perceived Benefits (+)	Management Commitment & Support (+) Organizational IT Competence (ns)	External Pressure (+) IS Vendor Support & Pressure (ns) Financial Resources Availability (ns)	Firm Size: Sales Revenue (ns) Firm Size: Workforce (ns) Firm Age (ns) Industry Type (ns) Intensity of Competition (ns)
Note: + = positively significant, - = negatively significant, ns = not significant, nc = not considered. If multiple dependent variables were investigated the results are separated by a comma.				

Table 12. Overview of the conceptualization and results of 38 quantitative studies using the TOE-framework

References of Literature Review on Studies Applying the TOE framework

Berger, S.C. and Martin, S.F. 2008. "Explaining the adoption of value metries in retail banks' customer management", in: *Enterprise Applications and Services in the Finance Industry,* D.J. Veit, D. Kundisch, T. Weitzel, C. Weinhardt, F.A. Rabhi, and F. Rajola (eds.). Berlin: Springer, pp. 151–164.

Chang, I.C., Hwang, H.G., Hung, M.C., Lin, M.H., and Yen, D.C. 2007. "Factors affecting the adoption of perspective of hospital electronic signature: Executives' information department", *Decision Support Systems* (44:1), pp. 350–359.

Chau, P.Y.K. and Hui, K.L. 2001. "Determinants of small business EDI adoption: An empirical investigation", *Journal of Organizational Computing and Electronic* (11:4), pp. 229–252.

Chau, P.Y.K. and Tam, K.Y. 1997. "Factors affecting the adoption of open systems: An exploratory study", *MIS Quarterly* (21:1), pp. 1–24.

Chwelos, P., Benbasat, I., and Dexter, A.S. 2001. "Research report: Empirical test of an EDI adoption model", *Information Systems Research* (12:3), pp. 304–321.

Cui, L., Zhang, C., Zhang, C.H., and Huang, L.H. 2008. "Exploring IT adoption process in Shanghai firms: An empirical study", *Journal of Global Information Management* (16:2), pp. 1–17.

Gibbs, J.L. and Kraemer, K.L. 2004. "A cross-country investigation of the determinants of scope of e-commerce use: An institutional approach", *Electronic Markets* (14:2), pp. 124–137.

Hsu, P.F., Kraemer, K.L., and Dunkle, D. 2006. "Determinants of e-business use in U.S. firms", *International Journal of Electronic Commerce* (10:4), pp. 9–45.

Huang, Z.Y., Janz, B.D., and Frolick, M.N. 2008. "A comprehensive examination of internet-EDI adoption", *Information Systems Management* (25:3), pp. 273–286.

Ifinedo, P. 2011a. "An empirical analysis of factors influencing internet/e-business technologies adoption by SMEs in Canada", *International Journal of Information Technology & Decision Making* (10:4), pp. 731–766.

Ifinedo, P. 2011b. "Internet/e-business technologies acceptance in Canada's SMEs: An exploratory investigation", *Internet Research* (21:3), pp. 255–281.

Kuan, K.K.Y. and Chau, P.Y.K. 2001. "A perception-based model for EDI adoption in small businesses using a technology-organization-environment framework", *Information & Management* (38:8), pp. 507–521.

Lee, S. and Kim, K.-j. 2007. "Factors affecting the implementation success of internet-based information systems", *Computers in Human Behavior* (23:4), pp. 1853–1880.

Li, D.H., Lai, F.J., and Wang, J. 2009. "E-business assimilation in China's international trade firms: The technology-organization-environment framework", *Journal of Global Information Management* (18:1), pp. 39–65.

Li, Y.H. 2008. "An empirical investigation on the determinants of e-procurement adoption in chinese manufacturing enterprises", in: *Proceedings of the 15th International Conference on Management Science and Engineering,* H. Lan (ed.). New York, NY, USA: IEEE, pp. 32–37.

Lin, C.Y. and Ho, Y.H. 2009. "RFID technology adoption and supply chain performance: An empirical study in China's logistics industry", *Supply Chain Management-an International Journal* (14:5), pp. 369–378.

Liu, C.F. 2011. "Key factors influencing the intention of telecare adoption: An institutional perspective", *Telemedicine and E-Health* (17:4), pp. 288–293.

Liu, M. 2008. "Determinants of e-commerce development: An empirical study by firms in Shaanxi, China", in: *Proceedings of the 4th International Conference on Wireless Communications, Networking and Mobile Computing*. Dalian, China: IEEE, pp. 9177–9180.

Mishra, A.N., Konana, P., and Barua, A. 2007. "Antecedents and consequences of internet use in procurement: An empirical investigation of U.S. manufacturing firms", *Information Systems Research* (18:1), pp. 103–120.

Mohamed, I.S., Omar, N., Daud, N.M., and Marthandan, G. 2009. "Assessing drivers of web technology investment in malaysia service industry: An application of technological, organizational, and environmental (TOE) model", in: *Proceedings of the international conference on information and multimedia technology*. Cheju Isl, South Korea: IEEE Computer Society, pp. 221–225.

Molla, A., Peszynski, K., and Pittayachawan, S. 2010. "The use of e-business in agribusiness: Investigating the influence of e-readiness and OTE factors", *Journal of Global Information Technology Management* (13:1), pp. 56–78.

Oliveira, T. and Martins, M.F. 2010. "Understanding e-business adoption across industries in european countries", *Industrial Management & Data Systems* (110:9), pp. 1337–1354.

Oliveira, T. and Martins, M.F.O. 2009. "Determinants of information technology adoption in Portugal", in: *Proceedings of the International Conference on E-Business*. Milan, Italy, pp. 264–270.

Pan, M.J. and Jang, W.Y. 2008. "Determinants of the adoption of enterprise resource planning within the technology-organization-environment framework: Taiwan's communications", *Journal of Computer Information Systems* (48:3), pp. 94–102.

Premkumar, G., Ramamurthy, K., and Crum, M. 1997. "Determinants of EDI adoption in the transportation industry", *European Journal of Information Systems* (6:2), pp. 107–121.

Premkumar, G. and Roberts, M. 1999. "Adoption of new information technologies in rural small businesses", *Omega-International Journal of Management Science* (27:4), pp. 467–484.

Rodriguez-Ardura, I. and Meseguer-Artola, A. 2010. "Toward a longitudinal model of e-commerce: Environmental, technological, and organizational drivers of B2C adoption", *Information Society* (26:3), pp. 209–227.

Soares-Aguiar, A. and Palma-Dos-Reis, A. 2008. "Why do firms adopt e-procurement systems? Using logistic regression to empirically test a conceptual model", *IEEE Transactions on Engineering Management* (55:1), pp. 120–133.

Teo, T.S.H., Lim, G.S., and Fedric, S.A. 2007. "The adoption and diffusion of human resources information systems in singapore", *Asia Pacific Journal of Human Resources* (45:1), pp. 44–62.

Teo, T.S.H., Lin, S.J., and Lai, K.H. 2009. "Adopters and non-adopters of e-procurement in singapore: An empirical study", *Omega-International Journal of Management Science* (37:5), pp. 972–987.

Teo, T.S.H., Ranganathan, C., and Dhaliwal, J. 2006. "Key dimensions of inhibitors for the deployment of web-based business-to-business electronic commerce", *IEEE Transactions on Engineering Management* (53:3), pp. 395–411.

Thong, J.Y.L. 1999. "An integrated model of information systems adoption in small businesses", *Journal of Management Information Systems* (15:4), pp. 187–214.

Wang, Y.M., Wang, Y.S., and Yang, Y.F. 2010. "Understanding the determinants of RFID adoption in the manufacturing industry", *Technological Forecasting and Social Change* (77:5), pp. 803-815.

Xu, S., Zhu, K., and Gibbs, J. 2004. "Global technology, local adoption: A cross-country investigation of internet adoption by companies in the United States and China", *Electronic Markets* (14:1), pp. 13–24.

Zhu, K., Dong, S., Xu, S.X., and Kraemer, K.L. 2006a. "Innovation diffusion in global contexts: Determinants of post-adoption digital transformation of european companies", *European Journal of Information Systems* (15:6), pp. 601–616.

Zhu, K. and Kraemer, K.L. 2005. "Post-adoption variations in usage and value of e-business by organizations: Cross-country evidence from the retail industry", *Information Systems Research* (16:1), pp. 61–84.

Zhu, K., Kraemer, K.L., and Sean Xu, K. 2003. "Electronic business adoption by european firms: A cross-country assessment of the facilitators and inhibitors", *European Journal of Information Systems* (12:4), pp. 251–268.

Zhu, K., Kraemer, K.L., and Xu, S. 2006b. "The process of innovation assimilation by firms in different countries: A technology diffusion perspective on e-business", *Management Science* (52:10), pp. 1557–1576.

PAPER III

THE BUSINESS VALUE OF SOA: AN EMPIRICAL EVALUATION OF THE IMPACT OF SERVICE ORIENTATION ON BUSINESS AND TECHNICAL GOALS

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Abstract

What is the business value of using a Service-Oriented Architecture (SOA)? Despite the potentially substantial role of the service-oriented paradigm, we find neither in academia nor practice any systematic, evidence-based insights on the differential impact of various approaches to implementing SOA on organizational goals such as cost reduction or agility. To bridge the gap between the mostly technical and thus far rather tenuous business understanding of SOA, we develop a multidimensional SOA business value model that embraces different services conceptions (business/IS/technology) on the one side and various business value manifestations on the other (cost reduction, agility, data quality, process monitoring, straight-through processing (STP), business-to-business (B2B) integration). Using data from 162 firms, we show that SOA contributes significantly to business goals in all six business benefit dimensions. Yet, most of the impact is indirect, mediated through an organization's dynamic capability of IT infrastructure flexibility, which itself is also increased by SOA.

1 Introduction

The concept of service orientation is widespread in the information technology (IT) domain (Mathiassen and Sorensen 2008) with the service-oriented architecture (SOA) concept and its supporting technologies, such as XML, Web Services, and so on, which are increasingly investigated in the last years (Viering et al. 2009). Moreover, entire organizations are moving to integrate their business components seamlessly, using services (Cherbakov et al. 2005) to break existing organizational forms that are oriented traditionally by business departments such as logistics, operations or marketing and sales. Applying service orientation to the business layer (i.e., Service-Oriented Enterprise (SOE)) as well enables new organizational forms and initiation of shared service centers (Janssen and Joha 2008). An organization is then no longer structured into traditional business departments but is modularized into business domains organized around shared services such as customer services, services for claims, customer data handling services, or billing services, as in the case of an insurance company (Janssen and Joha 2008).

Vitharana et al. (2007, p. 3) propose that "service orientation helps to execute the business strategy of an enterprise with significant multi-dimensional benefits (flexibility to change, enhanced quality, effectiveness), in less time (time-to-value) and cost (efficiency) using IT". This is one reason, according to a Forrester Research study, that 74 percent of the world's 2,000 largest enterprises (by number of employees) already use SOA (Heffner 2009). However, the same study echoes the concern that SOA does not naturally lead to benefits. Of those surveyed, only 20 percent stated that SOA has delivered most or all of the expected benefits, while 50 percent realized fewer benefits or struggled to realize any of the expected benefits (Heffner 2009). Thus, our research question is: *What is the business value of a Service-Oriented Architecture (SOA)?*

While researchers have investigated intensively the technical challenges surrounding SOA, a business perspective on SOA appeared more recently. It investigates the business value (Mueller et al. 2010) and organizational challenges of SOA (Varadan et al. 2008) or factors in the decision to adopt SOA (Beimborn et al. 2008; Choi et al. 2010; Ren and Lyytinen 2008; Vitharana et al. 2007). As part of this business perspective, we have seen the emergence of an increasing number of case studies (e.g., Baskerville et al. 2005; Hirschheim et al. 2010; Yoon and Carter 2007) and first quantitative studies that focus on specific SOA benefits (e.g., information sharing in supply chains (Kumar et al. 2007), organizational integration (Oh et al. 2007), business process quality (Beimborn and Joachim 2011) or effects on joint venture value (Tafti et al. 2008)).

Yet, there is still no empirical study that assesses the business value of SOA comprehensively. In addition, the results of a literature search show that the organizational impact of SOA is by far the least researched area; it is the subject of only 19 of 175 SOA papers identified (Viering et al. 2009). Since the oft-postulated business value of SOA has not yet been confirmed quantitatively, closing this research gap is particularly important for managers, especially given that there is typically a high cost associated with introducing SOA.

To address the manifold conceptualizations and perceptions of the SOA paradigm, we develop a comprehensive multilayered SOA concept that encompasses the service orientation at the business, information systems (IS), and technology levels. We also use a multidimensional SOA business value concept comprising operational, managerial, strategic, IT infrastructure, and organizational benefits (see Table 2 on page 48 for detailed definitions). The results can help managers assess whether implementing SOA will yield the benefits they expect and researchers to understand not only the business value SOA generates in particular but also the business value of IT architectures in general.

In the next section, we provide an overview of the relevant literature on SOA, IT flexibility, and dynamic capabilities theory, which serves as a theoretical foundation for our research. We then develop the research model, explain the data used to estimate the model, and present the results of the model estimation. Finally, we discuss the results and highlight our contribution and areas for further research.

2 Theoretical Background

2.1 Service-Oriented Architecture

SOA is based on separating business processes from their underlying IT by establishing a new service layer between the two (Siedersleben 2007). The service layer comprises of loosely coupled modular services whose communication and integration is supported by an enterprise service bus (ESB). The literature provides a variety of definitions of SOA (Erickson and Siau 2008) that differ with respect to what they encompass. Basically, we can distinguish between the definitions that limit SOA purely to the IT layer and those that explicitly include the business layer:

- Representing the first group, Krafzig et al. (2005, p. 57) define SOA as “a software architecture that is based on the key concepts of an application frontend, service, service repository, and service bus.”
- By contrast, Lublinsky (2007) defines SOA in business terms “as an architectural style promoting the concept of business-aligned enterprise service as the fundamental unit of designing, building, and composing enterprise business solutions.” This leads to the concept of the Service-Oriented Enterprise (SOE) (Janssen and Joha 2008, p. 35): “The SOE is an enterprise that is modularized in business domains.” Such a service-oriented view on an enterprise will consequently facilitate setting up shared ser-

vice centers, which support the creation of “new products […] by orchestrating the services provided by the service centers.”

- Bieberstein et al. (2005, p. 5) offer a holistic definition of SOA that covers both the IT perspective as well as the business: They define SOA as a “framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities.”

Since both academics and practitioners are often confused about the actual meaning of SOA (Viering et al. 2009), a consistent conceptualization is a core challenge for useful empirical SOA research and for tackling research questions dealing with the adoption of SOA and the subsequent business outcomes. As SOA has only rarely and rudimentarily been conceptualized and operationalized in previous studies, existing concepts and measures for investigating the extent of SOA in a firm are not available. For example, Kumar et al.’s (2007) conceptualization of SOA focuses on the binary assessment of using some of the technologies commonly applied for implementing SOA (XML and Web Services), whereas Tafti et al. (2008, p. 13) consider “the number of business functions for which SOA is used” as well as “the deployment of services-based architecture” in addition to XML and Web Services to measure SOA with four single items. By contrast, Oh et al. (2007) account for general architectural design principles and again some typical technologies (i.e., XML, WSDL, SOAP, and UDDI). Thus, we need a more comprehensive and unifying SOA research construct to capture SOA in a holistic way.

We draw on all these different views to investigate the business value of the entire concept of service orientation at the IT and the business levels. Therefore, we propose integrating the different definitions by assessing the service orientation of the enterprise architecture, which allows for comparing the degree of service orientation along the classical layers of enterprise architecture (EA) frameworks or models as published by various authors and institutions. However, the numbers of layers of those EA frameworks vary. For example, Winter and Fischer (2007) distinguish five layers in their EA representation (business, process, integration, software, and technology architectures). By contrast, Brown and Karamouzis (2001) use only three layers (business process, business applications, and infrastructure), which is also the case in Meschke and Baumoel (2010), who consolidate Winter and Fischer’s EA representation consisting of five layers down to three layers: process, application, and system architectures. Using only three layers to describe an EA is consistent with the widely used EA framework TOGAF 9 (The Open Group Architecture Framework) (The Open Group 2009), which distinguishes business, IS (comprising data and application architecture), and technology architectures. Table 1 compares how these EA frameworks map to each other:

<table>
<tr><th>TOGAF 9
(The Open Group 2009)</th><th>Meschke and Baumoel (2010)</th><th>Brown and Karamouzis (2001)</th><th>Winter and Fischer (2007)</th></tr>
<tr><td rowspan="2">business architecture</td><td rowspan="2">process architecture</td><td rowspan="2">business process</td><td>business architecture</td></tr>
<tr><td>process architecture</td></tr>
<tr><td rowspan="2">IS architecture
(data and application architecture)</td><td rowspan="2">application architecture</td><td rowspan="2">business applications</td><td>integration architecture</td></tr>
<tr><td>software architecture</td></tr>
<tr><td>technology architecture</td><td>system architecture</td><td>infrastructure</td><td>technology architecture</td></tr>
</table>

Table 1. Comparison of enterprise architecture frameworks

To evaluate the degree to which an organization has implemented the SOA paradigm, we analyze the degree of service orientation on each of the three layers (using the TOGAF terms). In addition, we analyze the service-oriented fit between the three different architectures as a fourth aspect of SOA implementation. Thus, applying four dimensions, we capture the overall concept of SOA implementation:

(1) Service-oriented business architecture: To determine the degree of service orientation of the business architecture, we analyze whether business activities are designed and managed following a service-oriented paradigm (i.e., identifying their core capabilities by using services-based modeling concepts for modeling business processes or to support organizing the enterprise in a service-oriented way by running and offering centralized and non-redundant (shared) business services (Janssen and Joha 2008)).
(2) Service-oriented IS architecture: To determine the degree of service orientation of the IS architecture, we consider whether the IS architecture actually follows the paradigm of service orientation. This includes the following design principles: separation of reusable logic, loose coupling, abstraction, and composability (Erl 2004).
(3) Service-oriented technology architecture: The technology architecture is assessed by the extent to which technologies are used that are related to the implementation of SOA, such as XML, Web Services, Enterprise Service Bus (ESB), service registry/repository, and business process execution language (BPEL) (cf. Kumar et al. 2007; Oh et al. 2007).
(4) Fit of service-oriented architectures: The three previous aspects focus on the degree of service orientation on each separate architecture layer. We also investigate the extent to which the organization's business processes are eventually based on SOA (in terms of (1), (2), and (3)), and thus integrate the three other layers to represent how well they fit from an all-encompassing service-oriented perspective.

Later, this multidimensional SOA research concept guides us in defining a holistic, multidimensional measurement model to capture empirically a holistic picture of the degree of an organization's SOA implementation.

2.2 IT Flexibility

One aim of introducing SOA, mentioned consistently in the literature, is to increase IT flexibility (Mueller et al. 2010; Yoon and Carter 2007). Duncan defines IT infrastructure flexibility as "the ability of the IS department to respond quickly and cost-effectively to systems demands, which evolve with changes in business practices or strategies" (1995, p. 44). Drawing on this definition, Byrd and Turner (2000) distinguish between the flexibility of the IT employees and the flexibility of the technical IT infrastructure. We limit our research to the latter since it is the layer where SOA plays its main role; nevertheless, we are aware that SOA will facilitate a knowledge exchange that is likely also to affect capabilities, and thus the flexibility of IT employees.

According to Duncan (1995), technical IT infrastructure flexibility depends mainly on the degree to which IT resources are reusable and commonly accessible. Based on these two aspects, Duncan defines three criteria for flexibility: (1) connectivity, which allows the connection of different components; (2) compatibility, which facilitates interaction and information exchange between connected components; and (3) modularity, which aims at "isolating and standardizing as many business and systems processes as possible" (1995, p. 48). Byrd and Turner give another definition of modularity: “the ability to add, modify, and remove any software, hardware, or data components of the infrastructure with ease and with no major overall effect” (2000, p. 171). Further, Byrd and Turner (2000) showed empirically that a separation of connectivity and compatibility does not hold. Thus, they suggest a new concept of “integration” that embraces both.

Chanopas et al. (2006) extended earlier research to suggest five additional aspects of technical IT flexibility, adding scalability, continuity, rapidity, facility, and modernity to modularity and integration. Of these, scalability – defined as “the degree to which hardware/software can be scaled and upgraded on existing infrastructure” (p. 645) – shows to be an important additional aspect for investigating the impact of service orientation, since SOA, given that it uses an ESB for integrating applications, is expected to be more scalable than point-to-point connections. However, point-to-point connections are problematic in that they are becoming very complex to handle, with an increasing number of systems to be integrated (Papazoglou and Heuvel 2007). Moreover, SOA targets increasing reuse of functionality, which relates directly to the concept of scalability.

2.3 Dynamic Capabilities Theory

Our research is based on the dynamic capabilities theory (DCT), which stands on the resource-based view (RBV). The RBV defines the characteristics resources must possess to deliver a sustained competitive advantage (Barney 1991; Penrose 1959): “sources of sustained competitive advantage are firm resources that are valuable, rare, imperfectly imitable, and non-substitutable” (1991, p. 101). Correspondingly, IT – comprising technical, personal and organizational components – can lead to a sustained competitive advantage and thus can be classified as a resource (Bharadwaj 2000; Melville et al. 2004).

One of the main criticisms of the RBV is that it offers only a rather static view on selecting the resources, rather than providing insights into how an organization can develop and integrate such resources to achieve a competitive advantage (Mahoney and Pandian 1992; Makadok 2001). The DCT addresses this shortcoming and defines “dynamic capabilities as the firm’s ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments” (Teece et al. 1997, p. 516). Accordingly, an organization’s competence to deal with its changing environment results from a dynamic capability.

Combining the perspectives of developing competencies with picking the right resources (Makadok 2001) and applying them to our research domain, SOA can be classified as a resource while (technical) IT flexibility is the resulting capability. In this way, we treat an implemented SOA as a resource that an organization can use for its purposes. To achieve more of the potential benefits SOA as a resource can offer, an organization needs a dynamic capability (i.e., (technical) IT flexibility). Thus, leveraging both SOA as resource and IT flexibility as a dynamic capability together will lead to strategic/sustainable business value.

3 Research Model

In this section, we develop our research model as visualized in Figure 1. The basic proposition is that SOA yields positive business value. We elaborate on how the different aspects of service orientation deliver which kinds of value to the firm. Then, drawing on the DCT, we add IT flexibility to the model as a mediating variable to explain the basic proposition. Finally, we investigate the role of service reuse, which is often mentioned as the main intermediary goal, in this context (Papazoglou and Heuvel 2007; Ren and Lyytinen 2008).

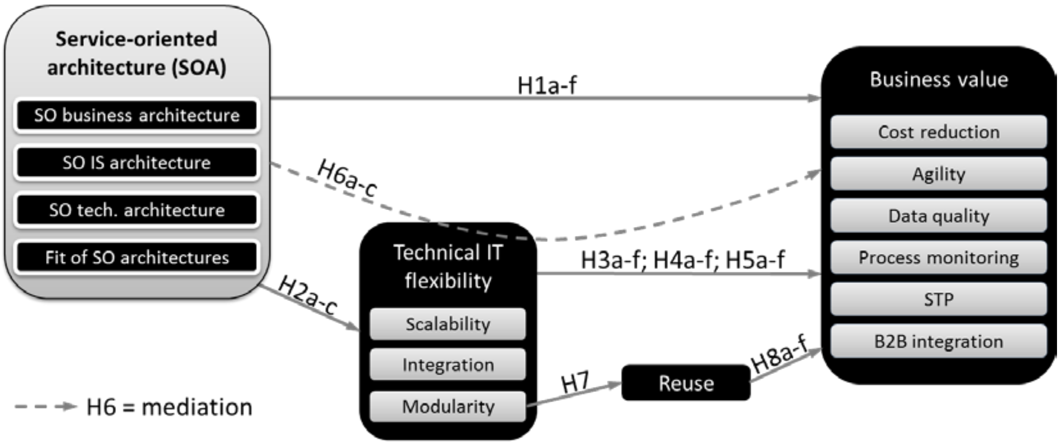

Figure 1. Research model

3.1 Business Value of Service-Oriented Architectures

The literature reveals different potential advantages that, in general, can be realized by SOA. This and the fact that such advantages are often not directly reflected in financial ratios (Shang and Seddon 2002; Uwizeyemungu and Raymond 2009) necessitate a multidimensional evaluation of SOA's value contribution.

An own comprehensive review of the SOA literature (Joachim 2011) shows that the various business advantages of SOA can be grouped into six basic categories, all of which have relevant meaning to SOA's business value. For example, reusing services and the resulting efficiency increases are expected to *reduce IT costs* in an organization that introduces SOA (Haines and Haseman 2009; Janssen 2008; Yoon and Carter 2007). Another oft-mentioned reason is *raising the business agility* of an organization, which allows it to react faster to changes in the environment, such as actions of competitors, or faster product launches (Baskerville et al. 2005; Yoon and Carter 2007). In addition, SOA is expected to *increase data quality* due to data consolidation and a better integration of application systems (Becker et al. 2009; Haines and Haseman 2009; Yoon and Carter 2007). The latter should also enhance business process quality as a result of *increased straight-through processing (STP)* and *easier process monitoring* (Becker et al. 2009; Haines and Haseman 2009). Finally, SOA is also seen as facilitating *business-to-business (B2B) integration*, since it allows for easier integration of organizations at lower costs (Baskerville et al. 2005; Becker et al. 2009; Kumar et al. 2007; Yoon and Carter 2007).

Mueller et al. (2010) conducted a secondary analysis of published case descriptions of SOA projects and grouped the identified advantages of SOA along five dimensions originally developed by Shang and Seddon (2002) for assessing the benefits of enterprise systems and based on an extensive literature analysis. Table 2 shows how the six categories of SOA's value contribution identified in the literature cover all five dimensions and are therefore consistent with previous works. While Mueller et al. (2010) used the five generic benefit dimensions from Shang and Seddon (2002) to group the various SOA benefit aspects identified in the case study descriptions, we use the six categories in our empirical research because this allows for a clearer separation of the different arguments of SOA's value contribution and thus better supports drawing conclusions from empirical findings.

Dimensions	Definitions (Shang and Seddon 2002, pp. 277-279)	Cost reduction	Agility	Data quality	Process monitoring	STP	B2B integration
Operational	"streamline processes and automate transactions provides business benefits by speeding up processes, substituting labour and increasing operation volumes"	X				X	X
Managerial	"allocation and control of the firm's resources, monitoring of operations and supporting of business strategic decisions"			X	X		
Strategic	"attainment of sustained IT-based competitive advantage"		X	X			
IT Infrastructure	"sharable and reusable IT resources that provide a foundation for present and future business applications"	X	X				
Organizational	"build integrated processes, improve employee communication, foster the development of a 'common vision' and user empowerment, support customer services and facilitate a flattening of organizational structure"					X	X
X: The dimension of the framework is taken into account by the respective category of SOA business value.							

Table 2. Mapping of SOA's business value contribution into Shang und Seddon's framework

Hypothesis H1a-f: *The use of SOA has a positive business value in terms of (a) cost reduction as well as by increasing (b) agility, (c) data quality, (d) process monitoring, (e) straight-through processing, and (f) B2B integration.*

3.2 IT Flexibility as Mediator

As explained earlier, modularity, integration (embracing connectivity and compatibility), and scalability are integrated into our research model as the three aspects of technical IT infrastructure flexibility. One aim of SOA is to create separate, modular services that can be integrated and/or reused more easily (Baskerville et al. 2005; Kumar et al. 2007; Oh et al. 2007; Yoon and Carter 2007). Also, firms implement SOA to increase the scalability of the IT infrastructure (Henningsson et al. 2007; Yoon and Carter 2007). A better scalable IT is able to handle increases in users, workload or transaction volume (Chanopas et al. 2006; Kumar 2004). SOA can, for example, contribute to scalability by using multiple ESBs as well as registering multiple versions of the same service to avoid possible bottlenecks due to increasing demands. These potentials or "capabilities" reflect the theoretical link between SOA as a resource and IT infrastructure flexibility as a dynamic capability in terms of the DCT.

Hypothesis H2a-c: *SOA increases technical IT infrastructure flexibility in terms of (a) modularity, (b) integration, and (c) scalability.*

Overall, a flexible IT infrastructure (i.e., high degrees of modularity, integration, and scalability) is expected to support reaching an organization's IT business value goals. For example, a flexible IT can offer new options for actions (Sambamurthy et al. 2003) or increase productivity (Dedrick et al. 2003). This results from cost savings, increased data quality, better internal as well as external (B2B) integration of business processes, and/or enhanced monitoring of processes to identify further options. Consequently, all three aspects of IT flexibility reflect dynamic capabilities that, according to the DCT, will contribute to the firm's success and thus deliver business value from IT (Melville et al. 2004).

Hypothesis H3a-f: *A higher degree of modularity of the technical IT infrastructure affects the business value positively in terms of (a) cost reduction as well as by increasing (b) agility, (c) data quality, (d) process monitoring, (e) straight-through processing, and (f) B2B integration.*

Hypothesis H4a-f: *A higher degree of integration of the technical IT infrastructure affects the business value positively in terms of (a) cost reduction as well as by increasing (b) agility, (c) data quality, (d) process monitoring, (e) straight-through processing, and (f) B2B integration.*

Hypothesis H5a-f: *A higher degree of scalability of the technical IT infrastructure affects the business value positively in terms of (a) cost reduction as well as by increasing (b) agility, (c) data quality, (d) process monitoring, (e) straight-through processing, and (f) B2B integration.*

Based on the causal logic of DCT, we combine hypotheses 2 through 5 and propose that SOA (i.e., as a resource) contributes to business value primarily by increasing IT flexibility (i.e., as a dynamic capability). By examining the mediation effect, we analyze whether this DCT-based explanation for SOA's value contribution holds.

Hypothesis H6a-c: *Technical IT infrastructure flexibility (in terms of (a) modularity, (b) integration, and (c) scalability) mediates the impact of SOA on business value.*[20]

3.3 Reuse as Mediator

One main argument behind service orientation is that functionality encapsulated in services can be reused and that these reuse opportunities are a major reason for the business value impact of such an orientation. From a theoretical standpoint, reusing existing services refers to the resource-picking perspective of the DCT.

Looking at Bieberstein et al.'s definition of "standardized components – services – that can be reused and combined to address changing business priorities" (2005, p. 5), one can see that reuse of services plays a prominent role in the SOA context. Thus, we put particular consideration into examining its role as a mediator (and, thus, as an explanation determinant).

In general, loosely coupled services (i.e., services showing a high degree of modularity) are more likely to be reused, as their functionalities are clearly separated from other services and therefore are easier to (re)use in other contexts, even though orchestration and interservice communication increase the management complexity of many loosely coupled services. In contrast, the functionality of tightly coupled services (i.e., services with a low degree of modularity) is difficult to reuse in other contexts, as a single service depends on many other services to provide its own functionality and is therefore separating it from its original context is a very complex task (Baskerville et al. 2005).

Hypothesis H7: *A higher level of modularity will increase the reuse of IT services.*

[20] Combining the three aspects of IT flexibility with the six different value contributions would actually lead to 18 hypotheses. For clarity, we group these 18 relationships into three underlying hypotheses.

Paolo Malinverno, a Gartner analyst, emphasizes that “reuse is not a benefit of SOA but a hurdle that needs to be overcome to improve business agility and lower software maintenance” (Saran 2006). Thus, we have not incorporated the reuse of existing functionality as a *dimension* of SOA’s business value, but as an additional mediating factor that *explains* SOA’s value contribution.

Hypothesis H8a-f: *A higher level of reuse will (a) reduce costs as well as increase (b) agility, (c) data quality, (d) process monitoring, (e) straight-through processing, and (f) B2B integration.*

4 Methodology and Results

4.1 Data Collection and Measurement

We conducted a survey with participants from the German service industry, including financial services, logistics, information and communication technologies (ICT), and so on, to evaluate the research model. We chose the service industry because IT, besides HR, is the most important factor for value creation, whereas physical resources, logistics, and the like are less relevant; thus, we can eliminate many industry-specific resource contingencies.

We phoned companies operating in the service industry (US SIC codes 4,000 to 8,999) to identify the leading manager responsible for the company's IT architecture. Next, we sent a paper questionnaire to the 955 contacts we had identified. After reminders via post, phone, and email we received 174 responses, representing an 18.2 percent response rate. Some of the responses showed single missing values, so we followed Kristensen and Eskildsen (2010), who simulated the impact of using different strategies for handling missing values and revealed that applying the expectation-maximization (EM) algorithm leads to more valid and reliable model estimation results than pairwise deletion or simple treatments such as mean value substitution. We applied the EM algorithm in a very conservative way only to those responses with at most four missing values regarding aspects of our research model (i.e., at most 8.3% missing values per item), eliminating the remaining data for evaluating our model. Ultimately, we used 162 questionnaires in the following analysis.

We evaluated the research model using Partial Least Squares (PLS) (smartPLS 2 M3 (Ringle et al. 2007)) and IBM SPSS Statistics 19. With the exception of SOA, all constructs of the research model are operationalized by reflective multi-item instruments. Before we developed the survey, we analyzed the related literature on SOA, IT flexibility, and the business value of IT. Where possible, the measurement instruments were derived from the literature (e.g., modularity, integration, and scalability) (cf. constructs, their measurement, and references to literature sources in Table 14). Other items, particularly for measuring the degree of SOA, were developed specifically for the purpose of this study[21] since there were no comparable studies available.

In total, we conducted nine case studies in large German service firms. Through the case study interviews, we examined different SOA implementation approaches at different layers of the enterprise architecture and what kinds of and how business value has resulted from SOA in the firms.

[21] The validation of the instrument was presented at an international IS conference (Joachim et al. 2011a).

We obtained a deep understanding about the mechanisms behind our research propositions and also learned the SOA lingo from many SOA industry experts, who gave us valuable feedback for developing our measures. Beyond the findings from the case study interviews and literature review, we also discussed the operationalizations of the new constructs with a group of seven experienced SOA researchers, to prevent the use of ambiguous, unclear, or over-lengthy formulated items. Moreover, an industry panel of consultants involved in SOA projects assessed the items and their respective content, which allowed us to refine the developed measurement instruments. As the panel proposed no additional items, we assume that the developed items cover the content domain sufficiently (Lewis et al. 1995). Altogether, these different validation approaches supported us in identifying ambiguous or unsuitable questionnaire items and improved the validity of the measurement instruments.

As explained earlier, we conceptualized SOA as a multidimensional construct and operationalized it based on our case studies and expert panels as a second-order construct, formed by the following four constructs:

(1) *Service-oriented business architecture* (reflective measure) represents the degree to which an organization follows the concept of the Service-oriented Enterprise (SOE) on the business level;

(2) *Service-oriented IS architecture* was measured reflectively by four items to assess the degree of service orientation of the firm's IS architecture;

(3) *Service-oriented technology architecture* was operationalized formatively by considering the use and range of application of five different technologies and standards frequently associated with SOA (XML, Web Services, ESB, registry/repository, and business process execution language (BPEL)) (Kumar et al. 2007; Oh et al. 2007);

(4) *Fit of service-oriented architectures* was measured formatively with five items by asking for the degree of SOA usage in five different areas of business operations.

Table 3 shows the complete operationalization of the SOA second-order construct.

Construct	Item	Measurement (SOB/SOI = reflective; SOT/FSA = formative)	Scale
Service-oriented business architecture	SOB1	We follow a service-oriented perspective when modeling business activities.	5-Likert scale from completely disagree to fully agree
	SOB2	Services are the primary concept for structuring the non-technical level.	
Service-oriented IS architecture	SOI1	Our firm has realized its IT architecture in an SOA-oriented manner.	7-Likert scale from completely disagree to fully agree
	SOI2	Our IT landscape follows the SOA paradigm as far as possible.	
	SOI3	Service orientation is the primary design principle of our IT architecture.	
	SOI4	All of our applications are integrated via service-oriented interfaces.	
Service-oriented technology architecture		To what extent are the following technologies used in your organization?	0 = {not known| not applied}; 1 = pilot usage; 2 = single projects; 3 = particular business area; 4 = multiple business areas; 5 = firm wide
	SOT1	• XML	
	SOT2	• Web Services (WSDL, SOAP)	
	SOT3	• Enterprise service bus (ESB) or other service-related bus	
	SOT4	• Registry / repository	
	SOT5	• Business process execution language (BPEL)	
Fit of service-oriented architectures		To what extent are the following processes supported by SOA?	5-Likert scale from "no SOA" to "solely supported by SOA"
	FSA1	• production/operations	
	FSA2	• procurement/B2B integration	
	FSA3	• research & development	
	FSA4	• marketing/sales/customer relations	
	FSA5	• secondary processes (accounting, HR etc.)	

Table 3. Operationalization of the second-order construct of SOA

As controls, we added firm size (log of number of employees) and industry sector (categorical variable covering other services, financial services, trade/logistics, and ICT) and used data from secondary sources. In addition, we used the firm's IT budget and the number of years the respondent has worked for the organization as further control variables.

4.2 Data Quality and Validity of the Measurement Model

Before validating the measurement model, we assessed whether the data are normally distributed. The Kolmogorov-Smirnov test as well as the skewness and kurtosis values, show that some items do not sufficiently resemble a normal distribution (Table 14 in the appendix). This, the rather limited sample size of 162 datasets and the use of formative measures were why we used PLS rather than covariance-based structural equation modeling (SEM), which would require more than 300 datasets, depending on the model complexity (Chin and Newsted 1999).

Next, we looked for indications for *non-response bias*. We split the dataset into two groups comprising those organizations that had responded immediately and those that had responded only after reminders. This approach is based on the assumption that the "lagging" group shares some similarities with firms that did not respond at all (Armstrong and Overton 1977). As no significant differences exist between the two groups with respect to the items used for evaluating the research model or with respect to industry type and organizational size, we assume that our data are not prone to non-response bias.

Further, we evaluated the validity and reliability of our measurement model. All of the indicators load highly on their associated factor ($\geq .707$) as requested by Nunnally (1978) (Table 14 in the appendix). Table 4 summarizes our criteria for assessing construct reliability and validity (convergent and discriminant validity). The composite reliabilities (C.R.) are all clearly higher than the requested threshold of .7 (Nunnally 1978) and the average variance extracted (AVE) of all constructs is well above the suggested .5 (Chin 1998). In addition, a sufficient degree of discriminant validity exists, as the square roots of the AVE (highlighted) are always higher than the correlations of the latent variables (Gefen et al. 2000). Moreover, the cross-loadings for each pair of indicators show to be lower than the indicators' loadings on their associated constructs (Table 13 in the appendix).

	C.R.	AVE	1	2	3	4	5	6	7	8	9	10	11	12
1 - Service-oriented business architecture	.950	.905	.951											
2 - Service-oriented IS architecture	.955	.842	.532	.918										
3 - Scalability	.868	.687	.246	.327	.829									
4 - Integration	.897	.685	.250	.359	.598	.828								
5 - Modularity	.915	.782	.816	.786	.312	.317	.884							
6 - Reuse	.926	.807	.232	.518	.569	.549	.129	.898						
7 - Cost reduction	.890	.618	.130	.198	.482	.470	.219	.297	.786					
8 - Agility	.917	.737	.257	.357	.457	.471	.136	.386	.274	.858				
9 - Data quality	.914	.842	.168	.275	.437	.436	.411	.275	.449	.435	.918			
10 - Process monitoring	.888	.799	.334	.349	.438	.485	.294	.355	.477	.327	.415	.894		
11 - STP	.854	.662	.370	.363	.496	.584	.350	.294	.599	.368	.573	.587	.813	
12 - B2B integration	.956	.880	.185	.236	.265	.415	.311	.297	.222	.239	.243	.249	.277	.938

Table 4. Reliability, convergent and discriminant validity (correlations of latent variables and square root of AVE (highlighted))

After ensuring that the reflective measurement models are valid and reliable, we tested the two formative measurement models of the first-order constructs, which constitute two of the four dimensions of the second-order SOA construct (i.e., service-oriented technology architecture and fit of service-oriented architectures). The significance levels of the items' outer weights (5 for each construct) vary between $p \leq .1$ and $p \leq .01$ using the bootstrapping procedure with 2.000 samples (Table 14 in the appendix). Only one indicator (FSA5) is not significant, but due to content validity reasons and based on the results of the exploratory factor analysis (Table 5) we decided to keep the indicator in the model, both because we follow a holistic approach and because it contributes to the completeness of the formatively measured construct.[22]

Formative measures may be inflated by multicollinearity. An analysis of the variance inflation factors (VIFs) shows that these are between 1.08 and 1.62 for service-oriented technology architecture and between 1.92 and 3.29 for fit of service-oriented architectures, which is mainly below the common suggestions of 3 or 10 as acceptable VIF thresholds according to the latest state-of-the art guidelines published in MIS Quarterly (Cenfetelli and Bassellier 2009; Diamantopoulos 2011). Thus, we conclude that multicollinearity is not a major issue biasing our results.

Based on the collected data for the 16 items of the four SOA dimensions, we performed an exploratory factor analysis (varimax rotation; cf. Table 5). The analysis explored four components with eigenvalues larger than 1, perfectly resembling the four SOA dimensions. Table 5 shows the results of the factor analysis. Without exception, all items load highly on their associated components, providing strong support for the statistical validity of the developed *SOA construct*.

[22] Moreover, this represents a more conservative approach. Leaving the indicator in the model simply adds noise and makes it more difficult to identify significant relationships. Thus, relationships found to be significant represent more robust results.

Item \ Factor	Service-oriented business architecture	Service-oriented IS architecture	Service-oriented technology architecture	Fit of service-oriented architectures
SOB1	**.791**	.374	.075	.083
SOB2	**.783**	.366	.147	.128
SOI1	.180	**.810**	.177	.340
SOI2	.259	**.809**	.146	.320
SOI3	.314	**.778**	.145	.287
SOI4	.197	**.799**	.077	.273
SOT1	-.314	.388	**.585**	.015
SOT2	-.045	.351	**.711**	.188
SOT3	.105	.016	**.736**	.177
SOT4	.358	.002	**.622**	.209
SOT5	.327	.031	**.489**	.267
FSA1	.189	.272	.255	**.747**
FSA2	.035	.250	.220	**.824**
FSA3	.113	.177	.128	**.786**
FSA4	.054	.345	.250	**.774**
FSA5	.076	.184	.092	**.836**
Eigenvalue	1.076	1.726	1.401	7.154
% of variance	6.72%	10.79%	8.76%	44.71%
Note: All factor loadings ≥ .4 are highlighted.				

Table 5. Results of the exploratory factor analysis for the SOA construct

Analyzing the path coefficients and their level of significance for the relationship of the first-order constructs to the second-order construct SOA (Figure 2) shows that the path coefficients range from .170 to .438 and are all highly significant at $p \leq .01$. This shows that in fact all of the four aspects of service orientation are important facets of SOA, which manifests itself at the entire multilayered enterprise architecture.

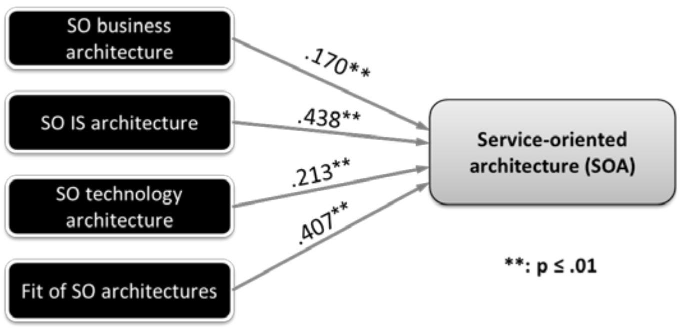

Figure 2. SOA construct (first-order → second-order)

Finally, we tested the data with respect to the existence of *common method bias* (CMB). First, we used Harman's single factor test and conducted an exploratory factor analysis, which revealed that the largest single factor explains only 27.1 percent of the variance, not the majority. Second, we conducted a marker variable test where we used a theoretically unrelated marker variable[23] as proxy for a common method factor and tested the impact of this factor on our model test results (Lindell and Whitney 2001; Podsakoff et al. 2003). We linked the marker variable to all dependent latent variables of our model (Figure 1), to partial out those fractions of the effects that might be conflated by CMB. Comparing the results of the model with and without the method factor shows

[23] "IT should facilitate access to new markets and regions." rated on a 7-Likert scale from "no aim" to "most important aim"

no structural difference between the test results: all significance levels of the hypothesized paths remain at exactly the same level. The largest absolute difference between path coefficients is .025 and all R^2 values remain unaffected (the largest delta is .020). Thus, we can assume that CMB is not likely to be a relevant issue in our data and results.

Overall, we conclude that the data and measurement models fulfill the usual requirements and provide a valid and reliable basis for further analysis of the structural model.

In the following section, we test our hypotheses. We follow an hierarchical approach to evaluate the existence and strength of potential mediation effects. The different models are visualized in Figure 3.

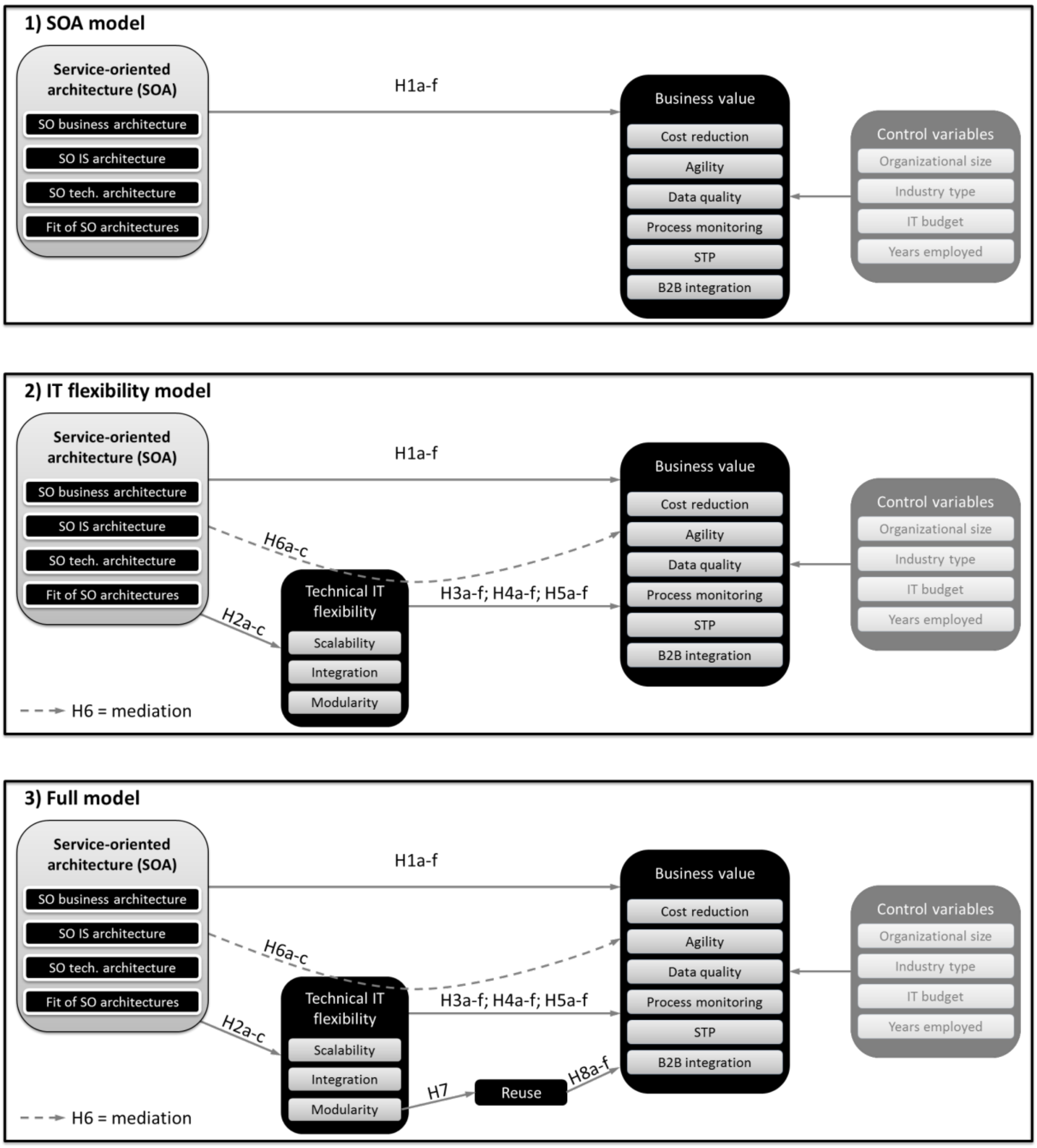

Figure 3. Tested model variants

4.3 Test of the Direct Relationships (SOA Model)

First, we analyzed SOA's contribution to business value (H1a-f) based on the SOA model, which contains only SOA, the business value dimensions, and the control variables, but not the mediating variables (IT infrastructure flexibility, reuse). Table 6 presents the R squares (R^2), path coefficients (β), as well as their level of significance. While the controls alone explain between 3.1 and 10.9 percent of the variances of the different value dimensions, SOA explains an additional 3.2 to 15.7 percent, resulting in a total of 10.1 to 21.2 percent. Even though SOA explains only a minor part of the variance of the different value dimensions, it shows consistent, strong, and highly significant impacts on all of the dimensions (H1a-f accepted).

SOA affects…		β	R^2	R^2 (only controls)	ΔR^2
H1a	Cost reduction	**.195****	.140	.108	.032
H1b	Agility	**.353****	.147	.031	.116
H1c	Data quality	**.233****	.101	.053	.048
H1d	Process monitoring	**.417****	.212	.055	.157
H1e	STP	**.329****	.174	.075	.099
H1f	B2B integration	**.240****	.163	.109	.054
Note: **: $p \leq .01$, significant relationships highlighted					

Table 6. R^2 and path coefficients (β) of the direct effects between SOA and business value dimensions (SOA model)

4.4 The Role of IT Flexibility for Explaining SOA's Business Value (IT Flexibility Model)

In the next step, we added technical IT infrastructure flexibility (modularity, integration, and scalability) (i.e., H2-H5) to the model. Table 7 contains the corresponding estimation results for the IT flexibility model.

Impact of ...		on ...								
		Modularity	Integration	Scalability	Cost reduction	Agility	Data quality	Process monitoring	STP	B2B integration
H1a-f H2a-c	SOA (β)	**.277****	**.354****	**.136***	.011	**.176****	.076	**.259****	**.128***	**.118***
H3a-f	Modularity (β)				**.292****	**.233****	**.186***	**.177***	**.183***	.020
H4a-f	Integration (β)				**.243****	**.304****	**.198***	**.222****	**.360****	**.276****
H5a-f	Scalability (β)				.028	-.021	**.276****	.073	**.155***	**.144***
Control variables	Organization size (β)				-.022	**.152***	-.006	-.035	-.004	.018
	Industry type (β)				-.009	.031	-.054	-.056	.034	**.119***
	IT budget (β)				-.064	**-.241****	-.071	-.004	-.055	**.136***
	Years employed (β)				**.191****	.031	.081	.090	**.119***	.072
	R^2:	.077	.125	.019	.320	.328	.316	.343	.423	.280
	R^2 (only controls):				.108	.031	.053	.055	.075	.109

Note: **: p ≤ .01; *: p ≤ .05, significant relationships highlighted

Table 7. R squares (R^2) and path coefficients (β) of the direct effects in IT flexibility model

The path coefficients from SOA to modularity (.277), integration (.354), and scalability (.136) are (highly) significant and resemble the positive impact of SOA on technical IT infrastructure flexibility (H2a-c confirmed). In addition, the path coefficients from SOA to the business benefits decrease strongly and become less significant or even insignificant, which reflects the mediation effect of IT flexibility (see our analysis of mediation effects below).

The proposed positive impacts of modularity on the business benefits can be confirmed except for B2B integration (H3a-e confirmed, H3f rejected). Further, integration is very important for achieving the business benefits, as it leads consistently to (highly) significant path coefficients between .198 and .360 (H4a-f confirmed). Scalability contributes only to three of the six business benefits (i.e., data quality, STP, and B2B integration; H5c,e,f confirmed), but shows no significant impact on cost reduction, agility, or process monitoring (H5a,b,d rejected).

Adding IT flexibility to the model raises the R squares of the six business value dimensions to values between 28.0 and 32.4 percent, which show the good explanatory power of this model.

Table 8 presents the effect sizes (f^2) for the IT flexibility model and shows that the predominate effects of using SOA are on integration, modularity, and process monitoring. While modularity is important for reducing costs, integration shows effects on all dimensions, but most notably on STP and B2B integration. Scalability shows its strongest effect on data quality.

Effect of ...		on ...								
		Modularity	Integration	Scalability	Cost reduction	Agility	Data quality	Process monitoring	STP	B2B integration
H1a-f H2a-c	SOA	**.08***	**.14****	**.02***	.00	**.04***	.01	**.08***	**.02***	**.02***
H3a-f	Modularity				**.08***	**.04***	**.03***	**.03***	**.03***	.00
H4a-f	Integration				**.05***	**.08***	**.03***	**.04***	**.12***	**.06***
H5a-f	Scalability				.00	.00	**.09***	**.02***	**.03***	**.03***

Note: **: medium effect, *: small effect according to Chin (1998)

Table 8. Effect sizes (f^2) in the IT flexibility model

4.5 Analysis of Mediation Effects (IT Flexibility Model)

Comparing the path coefficients between SOA and the business benefits of the SOA model (Table 6) and the IT flexibility model (Table 7) implies the existence of mediation effects. In this section, we conduct additional mediation tests for the three aspects of the technical IT infrastructure flexibility (modularity, integration, and scalability). This allows us to assess the degree to which the value contribution of SOA can be explained by technical IT infrastructure flexibility (H6a-c). We used the SOA model (Table 6) as a starting point but add the three potential mediators *one by one* for three separate model estimations. This approach allows us to analyze which of the flexibility dimensions mediates and thus explains which part of the relationship between SOA and the business benefits (Baron and Kenney 1986).

To make the mediation analysis more comprehensible, the first row of Table 9 repeats the path coefficients as they were estimated for the first (reduced) model (Table 6). The subsequent rows of Table 9 present the path coefficients of each of the three model estimations, each of which include only one of the potential mediators. The last row summarizes the test results from evaluating the mediation hypotheses H6a to H6c based on Sobel's z-test (Shrout and Bolger 2002) used to assess the level of statistical significance of the mediation effects. Additionally, the variance accounted for (VAF) shows the strength of the mediation effects (Shrout and Bolger 2002).[24]

Hayes highlights that "we should not be using tests that assume normality of the sampling distribution when competing tests are available that do not make this assumption and that are known to be more powerful than the Sobel test" (2009, p. 411); therefore, we have taken additional mediation tests into account. Based on the results from Preacher and Hayes (2004) as well as Hayes (2009), which show that indirect effects usually are not normally or symmetrically distributed, we follow their suggestion to bootstrap the sampling distribution as alternative to the Sobel test. Thus, Table 9 shows also the lower and upper bounds of the (95% or 99%) confidence intervals based on 2,000 bootstrap samples as well as the respective point estimates. Adding modularity or integration to the model has the strongest effect since this shows that all the Sobel-z values as well as the bootstrap-based point estimates show to be (highly) significant; flexibility turns, in particular, the highly significant paths between SOA and cost reduction as well as (in the case of integration) data quality into non-significant relationships. The VAFs show that up to 43 percent (38%) of the relationship between SOA and most business benefits can be explained by integration (modularity). SOA's impact on cost reduction is largely explained by both modularity and integration, which means that SOA leads to cost reduction and higher data quality almost purely because it increases

[24] Typically, authors define a mediation effect in which the remaining direct path from exogenous to endogenous variable becomes insignificant to be a "full mediation effect." Using this approach, modularity and integration in our analysis would "fully mediate" the relationship between SOA and cost reduction or data quality. However, we preferred to follow a more conservative approach by calculating the VAFs. A full mediation effect would imply a VAF of 1.0. Many of those authors who have identified "full mediators" according to the definition above do not take into account that the size of their data sets may not be large enough to have sufficient statistical power for avoiding type-II-errors. When talking about "full mediation," one must be sure (in a statistical sense) that the non-significant path is a non-existing relationship and not simply an existing relationship too weak to be identified in a smaller data set, which often does not provide necessary statistical power.

IT flexibility in terms of modularity and integration. Further, the bootstrapped point estimates for modularity and integration are between .060 and .183 and are all highly significant.

By contrast, the degree of explanation provided by scalability is far lower. According to the Sobel test, only three of the six relationships are mediated by scalability at all, and the VAFs of those are comparably low (between 11% and 18%), while the bootstrapped samples are, except for agility, all (highly) significant but still very low (from .026 to .051) and thus confirm the rather unimportant role of scalability for mediating (i.e., explaining the business value of SOA).

Overall, we can conclude that H6a (modularity) and H6b (integration) are completely confirmed while H6c (scalability) is mainly confirmed (five of six relationships) but has a very limited effect. Overall, the mediation analysis shows the importance of technical IT infrastructure flexibility as a mediator (i.e., as an explanatory factor for SOA's contribution to business value). However, it also shows that there is room left for further explanatory factors that are not captured by technical IT flexibility; these are discussed later.

Impact of SOA ...		*on ...*								
		Modularity	Integration	Scalability	Cost reduction	Agility	Data quality	Process monitoring	STP	B2B integration
	without mediators (ß)				.195**	.353**	.233**	.417**	.329**	.240**
	with modularity (ß)	.276**			.059	.233**	.120*	.310**	.199**	.174*
	with integration (ß)		.352**		.046	.201**	.102	.284**	.150*	.123*
	with scalability (ß)			.136*	.175**	.341**	.189**	.386**	.297**	.214**
H6a	Modularity	Sobel-z:			3.185**	2.964**	3.126**	2.957**	3.229**	2.154*
		VAF:			.38	.23	.30	.18	.26	.20
		Lower bound:			.031**	.023**	.029**	.025**	.032**	.004**
		Upper bound:			.243**	.233**	.196**	.181**	.221**	.145**
		Point estimate:			.121	.109	.104	.091	.118	.060
H6b	Integration	Sobel-z:			3.537**	3.652**	3.449**	3.300**	4.038**	3.140**
		VAF:			.43	.30	.36	.23	.35	.33
		Lower bound:			.054**	.060**	.051**	.043**	.074**	.043**
		Upper bound:			.270**	.289**	.256**	.249**	.318**	.238**
		Point estimate:			.149	.158	.136	.127	.183	.123
H6c	Scalability	Sobel-z:			1.444	1.198	1.828*	1.602	1.749*	1.685*
		VAF:			.11	.04	.18	.06	.11	.12
		Lower bound:			.001*	*not sig-*	.001**	.002*	.001**	.001**
		Upper bound:			.069*	*nificant*	.128**	.074*	.109**	.109**
		Point estimate:			.026	.016	.051	.030	.040	.035
Note: **: p ≤ .01; *: p ≤ .05, significant relationships are highlighted										

Table 9. Path coefficients (β) of direct effects with and without IT flexibility mediators, Sobel's z values and VAF values, as well as the results of bootstrapping-based mediation analysis (boundaries of confidence intervals and point estimates)

4.6 The Role of Reuse for Explaining SOA's Business Value (Full Model)

In a third and final step, we added *reuse* to test the full research model. Beyond some deviations in other path coefficients, the results in Table 10 show that modularity strongly and positively affects reuse, but that reuse has only a negative impact on STP and no impact on any of the other dimensions. The negative impact on STP (-.174) results from a statistical suppressor effect. In the previous IT flexibility model, modularity had a significant impact of .183 on STP, but now modularity has a very strong and highly significant impact on reuse (.569) and a highly significant impact of .246 on STP. Thus, the path from reuse to STP has to be suppressed to keep the total effect of modularity on STP at its previous level. Thus, we can conclude that even though modularity has a highly significant positive impact on reuse (H7 confirmed), reuse by itself plays no important role for achieving SOA's business value (H8a-f rejected).

	Impact of ...	*on ...*									
		Modularity	Integration	Scalability	Reuse	Cost reduction	Agility	Data quality	Process monitoring	STP	B2B integration
H1a-f H2a-c	SOA (β)	.277**	.354**	.137*		.023	.167*	.081	.262**	.175**	.100
H3a-f H7	Modularity (β)				.569**	.308**	.222*	.193*	.180*	.246**	-.006
H4a-f	Integration (β)					.254**	.293**	.203*	.226**	.408**	.256**
H5a-f	Scalability (β)					.024	-.018	.274**	.115	.135*	.181**
H8a-f	Reuse (β)					-.044	.034	-.020	-.011	-.174**	.071
Control varia-bles	Organization size (β)					-.021	.151*	-.006	-.034	.002	.016
	Industry type (β)					-.008	.030	-.053	-.056	.041	.116*
	IT budget (β)					-.065	-.241**	-.071	-.004	-.058	.138*
	Years employed (β)					.190**	.032	.081	.090	.114*	.074
	R^2:	.077	.125	.019	.323	.320	.329	.316	.343	.439	.283
	R^2 (only controls):					.108	.031	.053	.055	.075	.109
Note: **: $p \leq .01$; *: $p \leq .05$, significant relationships highlighted											

Table 10. R squares (R^2) and path coefficients (β) of the direct effects in the full model

Table 11 summarizes the findings regarding the business value of SOA based on the evaluation of our research model.

Test of Hyp.	*Impact of ...*	*on ...*									
		Modularity	Integration	Scalability	Reuse	Cost reduction	Agility	Data quality	Process monitoring	STP	B2B integration
H1a-f: confirmed H2a-c: confirmed	SOA (direct)	✓	✓	✓		✓	✓	✓	✓	✓	✓
H3a-e: confirmed H3f: rejected H7: confirmed	Modularity				✓	✓	✓	✓	✓	✓	✗
H4a-f: confirmed	Integration					✓	✓	✓	✓	✓	✓
H5a,b,d: rejected H5c,e,f: confirmed	Scalability					✗	✗	✓	✗	✓	✓
H8a-f: rejected	Reuse					✗	✗	✗	✗	✗	✗
H6a: confirmed	SOA (mediated by modularity)					✓	✓	✓	✓	✓	✓
H6b: confirmed	SOA (mediated by integration)					✓	✓	✓	✓	✓	✓
H6c: largely confirmed	SOA (mediated by scalability)					✓	✗	✓	✓	✓	✓
Note: ✓ significant positive relationship; ✗ no significant relationship; empty cell means relationship not hypothesized;											

Table 11. Summary of model evaluation results

4.7 Post-hoc Cluster Analysis of SOA Implementation Approaches

As a post-hoc analysis, we conducted a cluster analysis to identify different approaches of SOA implementation taken by the participating organizations. This additional analysis allows us to compare whether differences with respect to the configuration of the four dimensions of the used multidimensional SOA construct (i.e., service-oriented business architecture, service-oriented IS architecture, service-oriented technology architecture, and fit of service-oriented architectures) exist and, if so, what impact they have on the achieved benefits.

To identify which SOA configurations are implemented by the organizations, we follow Malhotra et al. (2005) and use a two-stage cluster analysis approach. This combined use of hierarchical and non-hierarchical cluster analysis methods is also recommended by Sharma (2008). In the first stage, we started with normalizing the values of all indicators used in the previous analysis to a range from 0 to 1 and calculating the means for each construct based on the measurement model presented in Table 14. Next, we performed a hierarchical cluster analysis using Ward's method based on the squared Euclidean distance, "which tries to minimize the total within-group or within-cluster sums of squares" (Sharma 2008, p. 193), with the four dimensions of the multidimensional SOA construct as input. Last, we assessed the dendogram as well as the coefficient created by Ward's method (Malhotra et al. 2005). Based on these two results, we chose the solution that identified five clusters in the remainder. For solutions with fewer clusters, the coefficient increases rapidly, which means that more heterogeneous clusters are combined. In the second stage, we assigned every firm to one of the five clusters using the non-hierarchical K-Means algorithm.

Figure 4 presents the identified clusters with respect to the four dimensions of the multidimensional SOA construct. Cluster 1 represents firms that have not applied service-oriented concepts at all. Cluster 2 firms concentrate on implementing a service-oriented business architecture, while ignoring other aspects. Organizations belonging to Cluster 3 show a balanced service-oriented configuration of their entire enterprise architecture at a medium level. In contrast, firms in Cluster 4 exhibit higher levels of service orientation regarding their IS and business architectures, but lower *fit* of service-oriented architectures. Finally, firms in Cluster 5 have reached a comparably high degree of service orientation on all layers of the enterprise architecture as well as regarding the fit of these layers. The figure also shows the absolute proportions of firms belonging to each of the clusters.

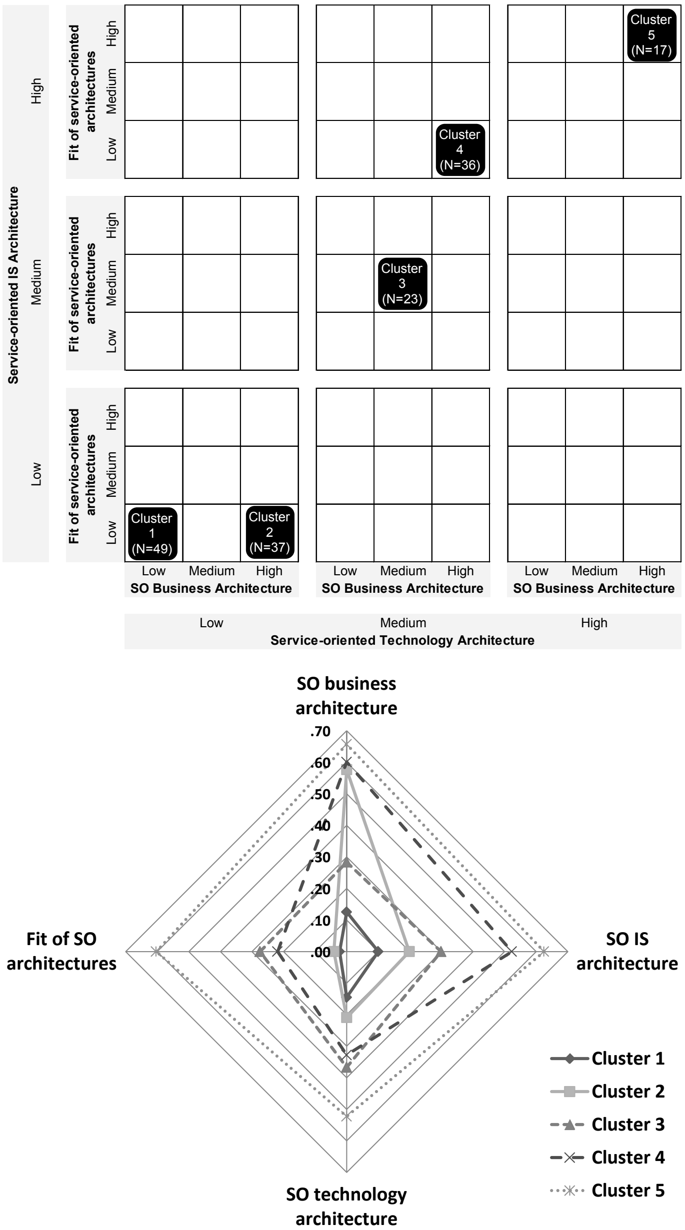

Figure 4. Visualization of SOA implementation approaches

Table 12 shows the mean, standard deviation (S.D.) and the number of organizations (N) for each cluster with respect to the constructs used in the previous analysis. While the first four rows reveal the different SOA implementation approaches with respect to the four aspects of a service-oriented enterprise architecture, the subsequent rows shed light on the impact of following different SOA configurations. Because all values have been normalized to a range from 0 to 1, the absolute differences between "neighbored" clusters are not very large. We applied the Jonckheere-Terpstra test to look for trends among the clusters (Field 2009). It tests "for a difference between the medians of the groups […] but it incorporates information about whether the order of the groups is meaningful" (Field 2009, p. 568). Since the cluster numbers presented in Figure 4 reflect increasing levels of service orientation of the entire enterprise architecture, this allows us to use the Jonckheere-Terpstra test to investigate whether implementing an SOA configuration in a more holistic way does have a positive impact on IT flexibility or SOA's business value. The last column of Table 12 reveals clearly that (with the exception of scalability and cost reduction) a more holistic SOA approach increases SOA's impact (effect size between .20 and .37) on the achieved IT flexibility as well as on the business value.

	Cluster 1 (N = 49)		Cluster 2 (N = 37)		Cluster 3 (N = 23)		Cluster 4 (N = 36)		Cluster 5 (N = 17)		Jonckheere-Terpstra-Test
	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	mean	S.D.	effect size
SO business architecture	.13	.14	.58	.14	.28	.15	.60	.13	.66	.16	.70 **
SO IS architecture	.10	.12	.20	.13	.30	.13	.52	.12	.63	.12	.91 **
SO technology architecture	.14	.11	.21	.14	.37	.17	.33	.15	.52	.17	.62 **
Fit of SO architectures	.02	.05	.04	.08	.27	.14	.22	.15	.60	.13	.76 **
Modularity	.47	.24	.58	.23	.51	.19	.58	.17	.63	.17	.21 **
Integration	.51	.21	.59	.17	.60	.16	.62	.17	.68	.24	.27 **
Scalability	.69	.22	.73	.21	.72	.14	.72	.19	.79	.21	.10
Reuse	.30	.21	.38	.22	.41	.22	.52	.23	.56	.21	.40 **
Cost reduction	.50	.21	.52	.20	.48	.18	.55	.18	.60	.17	.09
Agility	.53	.23	.58	.22	.57	.17	.67	.13	.71	.16	.29 **
Data quality	.68	.17	.71	.20	.70	.18	.76	.13	.79	.20	.20 **
Process monitoring	.39	.21	.53	.22	.48	.20	.56	.25	.71	.19	.37 **
STP	.55	.20	.62	.19	.60	.21	.69	.15	.74	.14	.31 **
B2B integration	.51	.24	.52	.25	.63	.16	.56	.21	.70	.21	.21 **

Note: **: p ≤ .01; *: p ≤ .05, significant results are highlighted

Table 12. Cluster analysis of SOA approaches

5 Discussion of the Results

SOA affects all enterprise architecture layers:

The applied multidimensional SOA concept and measurement model adequately consider the various definitions of SOA ranging from purely IT-focused to business-focused. The composition of the multidimensional SOA construct argues that all dimensions contribute to an overall service orientation of the firm's architecture (both technical and business). Thus, measuring the degree of service orientation on *all* layers of common enterprise architecture frameworks (i.e., business, IS, and technology architectures) complemented by the degree of service-oriented fit of these architectures offers a holistic picture of the total degree of SOA within a particular organization. In addition, the cluster analysis reveals that there are organizations focused only on service orientation of the business architecture (i.e., Cluster 2), but no cluster was identified which solely concentrates on the service orientation of the technology and/or IS architecture. These approaches were always accompanied by business architecture efforts (e.g., Clusters 3, 4, and 5).

SOA provides a significant business value contribution:

Overall, the results show that using a service-oriented architecture (SOA) makes a significant value contribution in terms of reducing costs and increasing business agility, data quality, process monitoring, internal STP, and B2B integration of processes (Table 6). While there are several strong effects that had been expected, such as a high impact of SOA on agility and integrative approaches (STP, B2B integration), it is notable that the strongest relationship turns out to be between SOA and process monitoring abilities. A possible explanation is that SOA is often accompanied by the introduction of comprehensive business process management (BPM) approaches (Beimborn and Joachim 2011; Brahe 2007; Woodley and Gagnon 2005).

The rather low R squares of the SOA model, though, show that SOA itself accounts for a rather minor part of these business benefits. This is plausible because these advantages are also influenced by many other organizational as well as IT-based determinants[25] (Francalanci and Morabito 2008). Moreover, the R square values are in similar ranges as those published in comparable studies (Aral and Weill 2007; Kumar et al. 2007; Ranganathan and Brown 2006). However, SOA turns out to be an effective means to achieve desirable business outcomes, even though other means have been applied in the past to achieve these outcomes.

SOA manifests in certain aspects of technical IT infrastructure flexibility:

The research model investigates the extent to which SOA affects the various aspects of technical IT infrastructure flexibility. As Table 7 shows, SOA is positively related with technical IT infrastructure flexibility, with a strong impact on modularity and integration and a weaker relationship with scalability. SOA's primary intent is to *modularize* business activities and the underlying IT implementations to *integrate* them more effectively, more efficiently, and more flexibly to serve the firm's business needs. By contrast, the weaker impact of SOA on the scalability of the IT architecture results from the SOA approach of most organizations in which the adoption of SOA is evolutionary, beginning in a single business area. While one possibility to increase scalability is the redundant use of multiple ESBs, only a very small proportion of the participating organizations in our survey have already established an *organization-wide* enterprise service bus or use an ESB at least *across different business areas*. Thus, when processing volumes increase, for example, it is likely that only a relatively small part benefits from SOA in terms of scalability, because SOA is in most cases not implemented enterprise-wide.

In turn, increased IT flexibility resulting from SOA contributes strongly to the six benefits. Adding IT flexibility as a mediator increases the explanatory power of our model with respect to the business value of IT. In particular, the very high importance of *integration* for achieving all six business benefits is apparent; it is the single-most important determinant for agility, STP, and B2B integration. Similarly, modularity is positively related with all business benefits, as well (except B2B integration). This is counterintuitive, since modularity itself creates loosely coupled services that can potentially be integrated internally (STP) with greater ease, but also externally (B2B integration). One explanation may be that this potential of easier integration of those loosely coupled services has not yet been leveraged to a significant extent. Most organizations in our sample started implementing SOA in specific areas of their business, which limits the potential of integrating partners. In addition, B2B integration depends not only on the focal firm's own IT architecture modularity, but also on the characteristics of the partner firm's infrastructure. By contrast, for organizations seeking to reduce their IT costs, modularity shows to be the single-most effective factor.

In total, the results show that SOA accounts for only a rather limited proportion of technical IT infrastructure flexibility. The highly significant path coefficients substantiate that SOA is an effective option to achieve a high degree of technical IT infrastructure flexibility; however, organiza-

[25] For example, the use of SOA can explain only a certain proportion of the variation in total IT costs. However, as the purpose of this paper is to investigate SOA's potential value impact and not to explain how the different benefits can be realized and explained to the fullest extent, the path coefficients are more important than the R squares.

tions are also able to implement flexible IT infrastructures without using service-oriented architectural paradigms at all.

SOA's business value contribution can be explained by technical IT infrastructure flexibility as a mediator:

Analyzing the role of technical IT infrastructure flexibility as a mediator of SOA's value contribution to the different business benefits overall confirms the hypothesis that SOA's business value is based mostly on classical aspects of IT infrastructure flexibility (i.e., modularity, integration, and scalability) or – theoretically spoken –to dynamic capability. While the bootstrap-based mediation tests identified 17 of the 18 potential mediation effects to be significant, the Sobel test validated only 15. With respect to modularity and integration, all relationships are mediated; this makes both substantial explanatory factors for the impact of SOA on business benefits. However, while the degree of explanation (VAF) is substantial in most cases, it does not exceed 43 percent.

Other hidden factors remain (in addition to statistical noise) that explain SOA's business value. One might be *business/IT alignment* (Chan and Reich 2007). When a firm is organized in a service-oriented manner both on the business and IT levels, there may be several positive effects such as, quite simply, an increased fit of task (business architecture) and technology (IS architecture) that are not necessarily related to higher IT flexibility. Alignment could also increase from a social perspective, since applying the service concept on the business and IT layers may lead to a better mutual understanding between business and IT (IT *and* business think in "services") (Erradi et al. 2006; Krafzig et al. 2005). This in turn enhances the quality of collaboration in joint implementation and change projects and thus enables the IT to provide more effective services to the business and thus to facilitate business performance (Joachim et al. 2011a). Finally, one must be aware that introducing a holistic service-oriented architecture in a firm usually accompanies other major organizational changes such as introducing BPM or fundamentally changing business processes within a BPR initiative (Brahe 2007; Woodley and Gagnon 2005). Such fundamental changes also lead to substantial improvements in business performance, although they are not directly related to increasing IT flexibility.

Reuse does not offer additional power to technical IT infrastructure flexibility for explaining SOA's business value:

Comparing the results in Table 7 and Table 10 reveals that adding reuse to the model does not offer any additional explanations about how SOA generates business value, because the paths from reuse to the business value dimensions are mostly insignificant (and even negative in one case). We did a post-hoc analysis in which we tested another model that included only reuse as mediator between SOA and the business benefits, excluding the IT infrastructure flexibility dimensions. In that case, we could observe strong and highly significant path coefficients from SOA to reuse and from reuse to the six business benefits. However, they occur only because the original explanatory variable (i.e., technical IT infrastructure flexibility) is missing. Taking the results together, we can conclude that reuse is achieved by SOA and a higher degree of modularity is a key enabler of reuse, but that business value of SOA is, notably, not improved by reuse of functionality. One explanation will be that the SOA implementations in the surveyed firms have yet to reach a mature and comprehensive enough stage (Joachim et al. 2011c) that allows the firms to utilize the benefits of reuse. Often, firms begin an SOA initiative in one local business segment; for example, financial service firms do their first SOA implementations in the retail sales process to facilitate multi-channel management. Until SOA has reached other parts of the firm, the potential for reusing functionality is rather limited. Thus, the actual impact of reuse on the investigated business benefits is too weak in our sample and is superseded by IT infrastructure flexibility.

Finally, our results show that the dynamic capabilities theory supports framing business value research in the domain of SOA. Also, we have seen that organizations achieve only limited parts of SOA's business potential from resource picking (i.e., implementing the concept of SOA) alone. Those organizations that also leverage (technical) IT flexibility as a complementary dynamic capability for utilizing SOA achieve significantly more business benefits from implementing SOA and thus can exploit more of its potential. Further, we observed that even though the potential for reuse is increased by modularity, it could not manifest itself in higher business benefits, which demands exploration of further capabilities that might be necessary to realize the business benefits of service reuse.

Limitations of the study

Since SOA business value is still a rather new phenomenon in empirical research, we had to adapt and develop new measurement instruments. However, the assessment of the measurement models shows that they are overall valid and reliable. Based on our literature review we have limited our research model to six business benefits. There may be other aspects for organizations we have not investigated, but that may be important business outcomes from applying SOA. Moreover, we have surveyed only organizations operating in one country (Germany) and one industry (service), which limits the generalizability of our results. However, this restriction also allows for a more robust interpretation of the results, as they are not influenced by contingency factors residing on the country level or industry level. Those are an important challenge in resource-oriented research, in particular (Melville et al. 2004).

Further, since we used a single (key) informant approach and have queried only the chief IT architects, who assumedly have the best information regarding the status of the SOA implementation and the general IT architecture of their organizations, the responses regarding the business benefits may be positively biased. However, we do not expect this to affect substantially the *covariances* between SOA and outcomes; the CMB test results (marker variable approach) support this assumption. In addition to the general advantages of using surveys to gather a rather broad dataset that is comparatively independent from being affected by single cases, this methodology also has disadvantages. For example, a detailed interpretation of single results and combinations of factors, as is done in case studies, is not possible. However, despite such potential limitations, we believe our approach delivers valuable and valid insights into the value dimension of SOA and represents a complementary contribution to the case study-based research works on SOA's business impacts that have already been published.

6 Contributions and Further Research

Our work offers a theoretical and empirical explanation for the business value contribution of SOA. The results substantiate the oft-proclaimed business value discussion of SOA by showing quantitatively the significant relationships between the degree of SOA and business-relevant value dimensions. So far, such analyses have been restricted to case studies. Our analysis shows that SOA in fact reduces costs and increases business agility, data quality, process monitoring, internal straight-through processing (STP) and external business-to-business (B2B) integration of processes.

Also, we show that the fuzzy concept of service-oriented architectures (SOA), with its definitions ranging from purely IT-focused to business-focused, can be measured adequately using the proposed multidimensional measurement model of SOA, which is based on common enterprise architecture frameworks. Thus, assessing the degree of service orientation on each of the layers of the enterprise architecture (i.e., business, IS, and technology architectures), accompanied by the degree of service-oriented fit of these architectures, leads to a holistic picture of the total degree of SOA within a particular organization.

Moreover, SOA's contribution to business value can be explained mainly by technical IT infrastructure flexibility in terms of modularity, integration, and scalability. These three positively affect the investigated business benefits and strongly explain *how* SOA delivers its business value. Based on the concept of dynamic capabilities, we have argued theoretically and shown empirically that technical IT infrastructure flexibility is a meaningful explanatory factor. SOA can represent an important IT resources that enables firms to create dynamic capabilities and thus leverage business value. In a next step, the non-technical flexibility aspects and their relationship should be investigated to obtain a more complete understanding of how SOA enables a firm's dynamic capabilities. However, quantitative approaches may be inadequate to examine SOA's impact on how people gain new capabilities and how they change their collaboration patterns to serve their firm's strategic needs effectively. Future research should also explore the "dark" side of SOA implementation, which often is related with high costs and structural risks from fundamental changes (Choi et al. 2010), into account.

For IT managers, our results show what they can expect from holistic SOA implementation and, as the cluster analysis shows, the extent to which business benefits are achievable when service-oriented principles are limited to some of the enterprise architecture layers. Thus, investment decisions regarding whether to adopt SOA and where to start to achieve quick returns can be made on more solid ground. Further, the results show that some benefits are achievable to only a limited degree by resource picking in terms of implementing SOA, but can be increased by IT flexibility as a dynamic capability and that reuse is not an imperative to achieve the desired business benefits and make SOA *valuable*. Future research should also examine the importance of complementary organizational factors (Melville et al. 2004), such as SOA governance (Joachim et al. 2011d; Joachim et al. 2011e) or business process standardization (Beimborn et al. 2009), to complete the picture regarding SOA's business value contribution.

7 References

Aral, S. and Weill, P. 2007. "IT assets, organizational capabilities, and firm performance: How resource allocations and organizational differences explain performance variation", *Organization Science* (18:5), pp. 763–780.

Armstrong, J.S. and Overton, T.S. 1977. "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research* (14:3), pp. 396–402.

Barney, J.B. 1991. "Firm resources and sustained competitive advantage", *Journal of Management* (17:1), pp. 99–120.

Baron, R.M. and Kenney, D.A. 1986. "The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology* (51:6), pp. 1173–1182.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Becker, A., Buxmann, P., and Widjaja, T. 2009. "Value potential and challenges of service-oriented architectures - a user and vendor perspective", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Beimborn, D. and Joachim, N. 2011. "The joint impact of service-oriented architectures and business process management on business process quality: An empirical evaluation and comparison", *Information Systems and e-Business Management* (9:3), pp. 333–362.

Beimborn, D., Joachim, N., and Münstermann, B. 2009. "Impact of service-oriented architectures (SOA) on business process standardization - proposing a research model", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Beimborn, D., Joachim, N., and Weitzel, T. 2008. "Drivers and inhibitors of SOA business value – conceptualizing a research model", in: *Proceedings of the 14th Americas Conference on Information Systems (AMCIS)*. Toronto, ON, Canada.

Bharadwaj, A.S. 2000. "A resource-based perspective on information technology capability and firm performance: An empirical investigation", *MIS Quarterly* (24:1), pp. 169–196.

Bieberstein, N., Bose, S., Fiammante, M., Jones, K., and Shah, R. 2005. *Service-oriented architecture (SOA) compass: Business value, planning, and enterprise roadmap*. Upper Saddle River, NJ: IBM Press.

Brahe, S. 2007. "BPM on top of SOA: Experiences from the financial industry", in: *Business process management,* P.D.G. Alonso and M. Rosemann (eds.). Heidelberg: Springer, pp. 96–111.

Brown, R.H. and Karamouzis, F. 2001. "The services value chain: Forging the links of services and sourcing", *Gartner Research*.

Byrd, T.A. and Turner, D.E. 2000. "Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct", *Journal of Management Information Systems* (17:1), pp. 167–208.

Cenfetelli, R.T. and Bassellier, G. 2009. "Interpretation of formative measurement in information systems research", *MIS Quarterly* (33:4), pp. 689–707.

Chan, Y.E. and Reich, B.H. 2007. "IT alignment: What have we learned?", *Journal of Information Technology* (22:4), pp. 297–315.

Chanopas, A., Krairit, D., and Khang, D.B. 2006. "Managing information technology infrastructure: A new flexibility framework", *Management Research News* (29:10), pp. 632-651.

Cherbakov, L., Galambos, G., Harishankar, R., Kalyana, S., and Rackham, G. 2005. "Impact of service orientation at the business level", *IBM Systems Journal* (44:4), pp. 653–668.

Chin, W.W. 1998. "The partial least square approach to structural equation modeling", in: *Modern methods for business research,* G.A. Marcoulides (ed.). Mahwah, NJ, USA: Lawrence Erlbaum Associates, pp. 295–336.

Chin, W.W. and Newsted, P.R. 1999. "Structural equation modeling analysis with small samples using partial least squares", in: *Statistical strategies for small sample research,* R.H. Hoyle (ed.). Thousand Oaks: Sage Publications, Ltd., pp. 307–341.

Choi, J., Nazareth, D.L., and Jain, H.K. 2010. "Implementing service-oriented architecture in organizations", *Journal of Management Information Systems* (26:4), pp. 253–286.

Chung, S.H., Byrd, T.A., Lewis, B.R., and Ford, F.N. 2005. "An empirical study of the relationships between IT infrastructure flexibility, mass customization, and business performance", *SIGMIS Database* (36:3), pp. 26–44.

Dedrick, J., Gurbaxani, V., and Kraemer, K.L. 2003. "Information technology and economic performance: A critical review of the empirical evidence", *ACM Computing Surveys* (35:1), pp. 1–28.

Diamantopoulos, A. 2011. "Incorporating formative measure into covariance-based structural equation models", *MIS Quarterly* (35:2), pp. 335–A335.

Duncan, N.B. 1995. "Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measure", *Journal of Management Information Systems* (12:2), pp. 37–57.

Erickson, J. and Siau, K. 2008. "Web services, service-oriented computing, and service-oriented architecture: Separating hype from reality", *Journal of Database Management* (19:3), pp. 42–54.

Erl, T. 2004. *Service-oriented architecture: A field guide to integrating XML and web services*. Upper Saddle River, NJ: Prentice Hall.

Erradi, A., Anand, S., and Kulkarni, N. 2006. "SOAF: An architectural framework for service definition and realization", in: *Proceedings of the 2006 IEEE International Conference on Services Computing*. Chicago, IL, USA.

Field, A.P. 2009. *Discovering statistics using SPSS*, (3 ed.). Los Angeles: Sage Publications, Ltd.

Francalanci, C. and Morabito, V. 2008. "IS integration and business performance: The mediation effect of organizational absorptive capacity in SMEs", *Journal of Information Technology* (23:4), pp. 297–312.

Gable, G.G., Sedera, D., and Chan, T. 2008. "Re-conceptualizing information system success: The IS-impact measurement model", *Journal of the Association for Information Systems* (9:7), pp. 1–32.

Gefen, D., Straub, D.W., and Boudreau, M.-C. 2000. "Structural equation modeling and regression: Guidelines for research practice", *Communications of the Association for Information Systems* (4:1), pp. 1–77.

The Open Group. 2009. *TOGAF version 9*, (9 ed.). Zaltbommel: Van Haren Publishing.

Haines, M.N. and Haseman, W.D. 2009. "Service-oriented architecture adoption patterns", in: *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA.

Hayes, A. 2009. "Beyond Baron and Kenny: Statistical mediation analysis in the new millennium", *Communication Monographs* (76:4), pp. 408–420.

Heffner, R. 2009. "Insights for CIOs: SOA and beyond", *Forrester Research*.

Henningsson, S., Svensson, C., and Vallen, L. 2007. "Mastering the integration chaos following frequent M&As: IS integration with SOA technology", in: *Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society.

Hirschheim, R., Welke, R., and Schwarz, A. 2010. "Service-oriented architecture: Myths, realities, and a maturity model", *MIS Quarterly Executive* (9:1), pp. 37–48.

Janssen, M. 2008. "Exploring the service-oriented enterprise: Drawing lessons from a case study", in: *Proceedings of the 41st Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society.

Janssen, M. and Joha, A. 2008. "Emerging shared service organizations and the service-oriented enterprise: Critical management issues", *Strategic Outsourcing: An International Journal* (1:1), pp. 35–49.

Joachim, N. 2011. "A literature review of research on service-oriented architectures (SOA): Characteristics, adoption determinants, governance mechanisms, and business impact", in: *Proceedings of the 17th Americas Conference on Information Systems (AMCIS)*. Detroit, MI, USA.

Joachim, N., Beimborn, D., Schlosser, F., and Weitzel, T. 2011a. "Does SOA create or require IT/business collaboration? Investigating SOA's potential to reduce the gap between IT and business", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*. Shanghai, China.

Joachim, N., Beimborn, D., and Weitzel, T. 2011b. "Eine empirische Untersuchung des Wertbeitrages von serviceorientierten Architekturen (SOA)", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Joachim, N., Beimborn, D., and Weitzel, T. 2011c. "An instrument for measuring SOA maturity", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*. Shanghai, China.

Joachim, N., Beimborn, D., and Weitzel, T. 2011d. "SOA-governance für effektive serviceorientierte Architekturen – Eine empirische Studie in der deutschen Dienstleistungswirtschaft", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Joachim, N., Beimborn, D., and Weitzel, T. 2011e. "What are important governance and management mechanisms to achieve IT flexibility in service-oriented architectures (SOA)?: An empirical exploration", in: *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS)*. Kauai, HI, USA: IEEE Computer Society, pp. 1–10.

Krafzig, D., Banke, K., and Slama, D. 2005. *Enterprise SOA: Service-oriented architecture best practices*. Upper Saddle River, NJ: Prentice Hall.

Kristensen, K. and Eskildsen, J. 2010. "Design of PLS-based satisfaction studies", in: *Handbook of partial least squares: Concepts, methods and applications,* V.E. Vinzi, W.W. Chin, J. Henseler, and H. Wang (eds.). Heidelberg: Springer, pp. 247–277.

Kumar, R.L. 2004. "A framework for assessing the business value of information technology infrastructures", *Journal of Management Information Systems* (21:2), pp. 11–32.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007. "SOA and information sharing in supply chain: "How" information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Lewis, B.R., Snyder, C.A., and Rainer, R.K. 1995. "An empirical assessment of the information resource management construct", *Journal of Management Information Systems* (12:1), pp. 199–223.

Lindell, M.K. and Whitney, D.J. 2001. "Accounting for common method variance in cross-sectional research designs", *Journal of Applied Psychology* (86:1), pp. 114–121.

Lublinsky, B. 2007. "Defining SOA as an architectural style: Align your business model with technology". retrieved 08/11/2010, from http://www.ibm.com/developerworks/architecture/library/ar-soastyle/.

Mahoney, J.T. and Pandian, R.J. 1992. "The resource-based view within the conversation of strategic management", *Strategic Management Journal* (13:5), pp. 363–380.

Makadok, R. 2001. "Toward a synthesis of the resource-based and dynamic-capability views of rent creation", *Strategic Management Journal* (22:5), pp. 387–401.

Malhotra, A., Gosain, S., and El Sawy, O.A. 2005. "Absorptive capacity configurations in supply chains: Gearing for partner-enabled market knowledge creation", *MIS Quarterly* (29:1), pp. 145–187.

Mathiassen, L. and Sorensen, C. 2008. "Towards a theory of organizational information services", *Journal of Information Technology* (23:4), pp. 313–329.

Melville, N., Kraemer, K.L., and Gurbaxani, V. 2004. "Review: Information technology and organizational performance: An integrative model of IT business value", *MIS Quarterly* (28:2), pp. 283-322.

Meschke, M. and Baumoel, U. 2010. "Architecture concepts for value networks in the service industry", in: *Proceedings of the 31st International Conference on Information Systems (ICIS)*. St. Louis, MI, USA, pp. 1–13.

Mueller, B., Viering, G., Legner, C., and Riempp, G. 2010. "Understanding the economic potential of service-oriented architecture", *Journal of Management Information Systems* (26:4), pp. 145–180.

Nunnally, J.C. 1978. *Psychometric theory*, (2. ed.). New York, NY: McGraw-Hill.

Oh, L.-B., Leong, Y.-X., Teo, H.-H., and Ravichandran, T. 2007. "Service-oriented architecture and organizational integration: An empirical study of IT-enabled sustained competitive advantage", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Papazoglou, M.P. and Heuvel, W.-J. 2007. "Service oriented architectures: Approaches, technologies and research issues", *The VLDB Journal* (16:3), pp. 389–415.

Penrose, E.T. 1959. *The theory of the growth of the firm*. Oxford, UK: Oxford University Press.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. 2003. "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Psychology* (88:5), pp. 879–903.

Preacher, K.J. and Hayes, A.F. 2004. "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods* (36:4), pp. 717–731.

Ranganathan, C. and Brown, C.V. 2006. "ERP investments and the market value of firms: Toward an understanding of influential ERP project variables", *Information Systems Research* (17:2), pp. 145–161.

Ren, M. and Lyytinen, K.J. 2008. "Building enterprise architecture agility and sustenance with SOA", *Communications of the Association for Information Systems* (22:1), pp. 75–86.

Ringle, C.M., Wende, S., and Will, A. 2007. "SmartPLS 2.0 (M3) Beta". Hamburg.

Sambamurthy, V., Bharadwaj, A., and Grover, V. 2003. "Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms", *MIS Quarterly* (27:2), pp. 237–263.

Saran, C. 2006. "SOA will fail without governance warns gartner". retrieved 08/11/2010, from http://www.computerweekly.com/Articles/2006/09/07/218322/soa-will-fail-without-governance-warns-gartner.htm.

Shang, S. and Seddon, P.B. 2002. "Assessing and managing the benefits of enterprise systems: The business manager's perspective", *Information Systems Journal* (12:4), pp. 271–299.

Sharma, S. 2008. *Applied multivariate techniques*, (15 ed.). New York, NY: Wiley.

Shrout, P. and Bolger, N. 2002. "Mediation in experimental and nonexperimental studies: New procedures and recommendations", *Psychological Methods* (7:4), pp. 422–445.

Siedersleben, J. 2007. "SOA revisited: Component orientation in system landscapes", *Wirtschaftsinformatik* (49:Special Issue), pp. 110–117.

Tafti, A., Mithas, S., and Krishnan, M.S. 2008. "The effects of information technology and service-oriented architectures on joint venture value", in: *Proceedings of the 29th International Conference on Information Systems (ICIS)*. Paris, France.

Tallon, P.P. 2008. "Inside the adaptive enterprise: An information technology capabilities perspective on business process agility", *Information Technology and Management* (9:1), pp. 21–36.

Teece, D.J., Pisano, G., and Shuen, A. 1997. "Dynamic capabilities and strategic management", *Strategic Management Journal* (18:7), pp. 509–533.

Uwizeyemungu, S. and Raymond, L. 2009. "Exploring an alternative method of evaluating the effects of ERP: A multiple case study", *Journal of Information Technology* (24:3), pp. 251–268.

Varadan, R., Channabasavaiah, K., Simpson, S., Holley, K., and Allam, A. 2008. "Increasing business flexibility and SOA adoption through effective SOA governance", *IBM Systems Journal* (47:3), pp. 473–488.

Viering, G., Legner, C., and Ahlemann, F. 2009. "The (lacking) business perspective on SOA - critical themes in SOA research", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 45–54.

Vitharana, P., Bhaskaran, K., Jain, H., Wang, H.J., and Zhao, J.L. 2007. "Service-oriented enterprises and architectures: State of the art and research opportunities", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA.

Winter, R. and Fischer, R. 2007. "Essential layers, artifacts, and dependencies of enterprise architecture", *Journal of Enterprise Architecture* (3:2), pp. 1–12.

Woodley, T. and Gagnon, S. 2005. "BPM and SOA: Synergies and challenges", in: *Web information systems engineering,* A.H.H. Ngu, M. Kitsuregawa, E.J. Neuhold, J.-Y. Chung, and Q.Z. Sheng (eds.). Heidelberg: Springer, pp. 679–688.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

8 Appendix

	SO business architecture	SO IS architecture	Modularity	Integration	Scalability	Reuse	Cost reduction	Agility	Data quality	Process monitoring	STP	B2B integration
SOB1	.947	.495	.138	.212	.049	.174	.095	.250	.188	.300	.283	.056
SOB2	.955	.517	.247	.262	.104	.263	.149	.239	.135	.334	.301	.147
SOI1	.446	.940	.309	.369	.135	.525	.224	.318	.289	.344	.363	.285
SOI2	.497	.947	.334	.322	.121	.483	.189	.297	.249	.332	.341	.245
SOI3	.547	.913	.292	.319	.040	.459	.153	.263	.241	.321	.340	.175
SOI4	.465	.869	.262	.308	-.017	.433	.157	.240	.230	.282	.275	.156
MOD1	.079	.274	.826	.584	.351	.543	.362	.439	.401	.339	.391	.274
MOD2	.210	.226	.840	.476	.298	.424	.385	.358	.394	.389	.453	.174
MOD3	.227	.313	.819	.418	.117	.441	.451	.333	.270	.363	.389	.207
ITG1	.177	.289	.524	.873	.313	.465	.354	.391	.399	.361	.529	.331
ITG2	.209	.315	.519	.883	.275	.430	.417	.362	.396	.368	.531	.341
ITG3	.227	.305	.475	.814	.252	.438	.491	.415	.440	.492	.509	.364
ITG4	.218	.279	.464	.733	.203	.501	.259	.398	.161	.354	.339	.337
SCA1	.050	.067	.357	.278	.871	.096	.166	.158	.387	.264	.292	.234
SCA2	.073	.017	.259	.246	.904	.083	.161	.062	.293	.215	.248	.259
SCA3	.091	.109	.218	.306	.878	.151	.240	.129	.393	.288	.368	.321
REU1	.234	.500	.478	.477	.089	.910	.272	.380	.248	.343	.287	.192
REU2	.205	.451	.568	.467	.131	.936	.283	.377	.240	.354	.278	.267
REU3	.186	.449	.482	.542	.128	.846	.243	.280	.255	.254	.226	.348
COR1	.092	.098	.255	.216	.241	.126	.707	.115	.278	.346	.329	.176
COR2	.063	.171	.367	.415	.131	.294	.840	.241	.321	.377	.484	.195
COR3	.099	.128	.348	.375	.203	.181	.777	.147	.272	.419	.396	.116
COR4	.132	.150	.510	.438	.116	.312	.820	.315	.459	.365	.530	.167
COR5	.121	.215	.361	.362	.206	.212	.780	.201	.397	.378	.573	.217
AGI1	.115	.198	.314	.237	.120	.262	.085	.735	.240	.170	.163	.223
AGI2	.201	.208	.370	.388	.046	.278	.214	.894	.345	.296	.317	.107
AGI3	.289	.294	.422	.500	.144	.376	.323	.918	.422	.350	.394	.277
AGI4	.242	.325	.443	.441	.151	.387	.255	.874	.445	.278	.342	.209
DAQ1	.163	.205	.391	.377	.430	.225	.409	.376	.926	.351	.505	.217
DAQ2	.145	.306	.400	.425	.320	.282	.415	.425	.909	.415	.551	.229
PRM1	.327	.390	.383	.398	.192	.369	.414	.330	.339	.892	.530	.189
PRM2	.270	.234	.400	.460	.333	.266	.439	.255	.402	.895	.520	.255
STP1	.172	.265	.342	.474	.226	.229	.477	.272	.441	.327	.725	.116
STP2	.290	.336	.391	.479	.316	.233	.479	.316	.552	.519	.859	.253
STP3	.279	.277	.471	.475	.306	.257	.508	.309	.405	.570	.849	.294
B2B1	.091	.194	.251	.369	.316	.287	.240	.228	.242	.265	.269	.942
B2B2	.125	.295	.292	.433	.304	.314	.231	.262	.256	.265	.304	.938
B2B3	.086	.164	.192	.357	.250	.227	.145	.174	.177	.158	.195	.934

Table 13. Cross-loadings of indicators with reflectively measured constructs

Construct (Sources of measures)	Label	Indicator (Scales: "fully disagree" to "fully agree" (5- or 7-step Likert scale); other scales are shown in Table 3) *(translated from German)*	Skewness	Kurtosis	Loadings (Weights)
Service-oriented business architecture	SOB1	We follow a service-oriented perspective when modeling business activities.	-.170	-1.081	.947**
	SOB2	Services are the primary concept for structuring the non-technical level.	-.004	-.982	.955**
Service-oriented IS architecture	SOI1	Our firm has realized its IT architecture in an SOA-oriented manner.	.536	-.684	.940**
	SOI2	Our IT landscape follows the SOA paradigm as far as possible.	.358	-1.075	.947**
	SOI3	Service orientation is the primary design principle of our IT architecture.	.403	-.880	.913**
	SOI4	All of our applications are integrated via service-oriented interfaces.	.633	-.345	.869**
Service-oriented technology architecture (Kumar et al. 2007; Oh et al. 2007)		To what extent are the following technologies used in your organization?			
	SOT1	• XML	-.043	-.111	(.177*)
	SOT2	• Web Services (WSDL, SOAP)	.306	-.693	(.484**)
	SOT3	• Enterprise service bus (ESB) or other service-related bus	1.087	-.060	(.131^{+})
	SOT4	• Registry / repository	1.161	.067	(.292*)
	SOT5	• Business process execution language (BPEL)	2.458	5.312	(.328**)
Fit of service-oriented architectures		To what extent are the following processes supported by SOA?			
	FSA1	• production/operations	1.158	.353	(.406**)
	FSA2	• procurement/B2B integration	1.274	.636	(.106^{+})
	FSA3	• research & development	1.770	2.540	(.152*)
	FSA4	• marketing/sales/customer relations	1.320	.935	(.416**)
	FSA5	• secondary processes (accounting, HR etc.)	1.587	1.666	(.057)
Modularity (Chung et al. 2005; Tallon 2008)	MOD1	We can add new functionality to our systems without having serious problems.	-.423	-.586	.826**
	MOD2	Exchanging or modifying single components does not affect our IT infrastructure.	-.316	-.725	.840**
	MOD3	Our systems consist of clearly separated modules.	-.169	-.893	.819**
Integration (Byrd and Turner 2000; Chanopas et al. 2006)	ITG1	Exchanging data between different systems is very easy.	-.310	-.484	.873**
	ITG2	Data of one system can be easily used in other systems.	-.297	-.289	.883**
	ITG3	We can easily create consolidated views about all data belonging to a customer.	-.162	-.862	.814**
	ITG4	We can integrate additional data formats (e. g. EDI, XML) easily in our applications.	-.427	-.675	.733**
Scalability (Chanopas et al. 2006; Gable et al. 2008)	SCA1	Out IT infrastructure can easily compensates peaks in transaction volumes.	-.886	-.043	.871**
	SCA2	Our IT infrastructure offers sufficient capacity in order to fulfill additional orders.	-1.138	.851	.904**
	SCA3	The performance of our IT infrastructure completely fulfills our business needs.	-.985	.949	.878**
Reuse	REU1	Usually, new functions of our systems can be realized by reusing existing components (e. g. services).	-.073	-1.099	.910**
	REU2	Many of our systems consist of reusable software components.	.197	-1.210	.936**
	REU3	Functionality of our legacy systems can easily be reused in other systems.	.464	-.561	.846**
Cost reduction	COR1	All potentials to optimize our IT operating costs were exploited.	-.398	-.740	.707**
	COR2	All potentials to reduce our software development costs were exploited.	-.298	-.622	.840**
	COR3	All potentials to optimize our IT management costs were exploited.	-.399	-.538	.777**
	COR4	The functionalities of our application systems are free from unnecessary redundancies.	.053	-1.077	.820**
	COR5	Business processes are not implemented multiple times in our organization.	-.227	-1.003	.780**
Agility (Chung et al. 2005; Tallon 2008)		Our IT enables our organization, …			.735**
	AGI1	… to flexibly adapt products / services to single customers.	-.561	-.384	.894**
	AGI2	… to change our product / service offerings faster than our competitors.	-.480	-.099	.918**
	AGI3	… to realize a shorter time-to-market than our competitors.	-.357	-.300	.874**
	AGI4	… to react quickly and flexibly to changes in customer demand.	-.530	.047	.926**
Data quality (Gable et al. 2008)	DAQ1	The date of our applications is complete and up-to-date.	-.771	.716	.909**
	DAQ2	The data of our applications does not contain errors and is consistent.	-.966	.746	.892**
Process monitoring	PRM1	Operational performance indicators of business processes (e. g., cycle time, errors) are available.	.159	-.894	.895**
	PRM2	The transparency of our business processes facilitates compliance.	-.222	-.728	.725**
STP	STP1	Our users are frequently required to re-enter the same data. (reverse coded)	-.595	-.941	.859**
	STP2	All of our applications are integrated, as long as reasonable from a business process perspective.	-.505	-.628	.849**
	STP3	The activities of our business units are integrated well.	-.605	-.161	.942**
B2B integration (Oh et al. 2007)	B2B1	The business processes of our organization are well integrated with those from our business partners.	-.363	-.599	.938**
	B2B2	We efficiently exchange data with our business partners.	-.476	-.652	.934**
	B2B3	Overall, the integration between our business partners and us is high.	-.239	-.938	.826**
Org. size	OSI	Logarithm of total number of employees (source: secondary data)			
Industry type	INT	Industry the firm is belonging to. Categorical variable: other services, financial services, trade & logistics, and IT & communication (source: secondary data)			
IT budget	ITB	Amount of firm's IT budget (< 10 mill. €, < 100 mill. €, < 250 mill. €, < 500 mill. €, < 1000 mill. €)			
Years employed	YEO	Years the respondent has worked for the surveyed firm.			
Note: significance levels of loadings/weights: **: $p \leq .01$, *: $p \leq .05$, $^{+}$: $p \leq .1$					

Table 14. Indicators used in the measurement model

PAPER IV

AN INSTRUMENT FOR MEASURING SOA MATURITY

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Abstract

Existing empirical research on the business value of Service-Oriented Architectures (SOA) has only measured the extent of SOA adoption – but not maturity – to determine whether typical goals, like increased business agility or IT cost reduction, could be achieved. However, a widely implemented SOA might be less mature than an SOA adopted only in particular areas of the organization, which in turn can lead to mismeasurement and misinterpretation. On the other side, the existing SOA maturity frameworks that have been specified by previous researchers lack valid operationalizations to make them applicable to empirical research. In particular, ready-to-use items and scales for evaluating the particular maturity level of an organization are missing.

We propose measuring the degree of SOA maturity as a new variable for future empirical research especially in the context of SOA business value. Our analytical approach uses 21 items to classify the maturity of an organization's SOA in seven maturity levels along seven maturity dimensions derived from The Open Group Service Integration Maturity Model (OSIMM). The applicability of this new instrument is shown using data from 121 organizations.

1 Introduction

Of the world's largest organizations (i.e., those having 20,000 or more employees) 84% employ Service-Oriented Architectures (SOAs), yet only 12% of those have realized all of their planned benefits (Heffner 2010). Among the remainder, 39% will expand their use of SOA even though it has delivered fewer benefits than expected, 16% will not expand the use until the issues which hamper the realization of benefits from SOA are resolved, while 32% are in a too early stage to decide, and only 1% will cut back their use of SOA (Heffner 2010). While much of the discrepancy between SOA adoption and actually realized benefits results from a lack of business perspectives (Joachim 2011; Joachim et al. 2011a) and SOA governance (Joachim et al. 2011c; Joachim et al. 2011d), there is also a substantial – and interesting – measurement challenge. On the one hand, some empirical studies investigate specific benefits of SOA (Kumar et al. 2007; Oh et al. 2007; Tafti et al. 2008), while on the other hand, all of them only measure the extent of fragments belonging to SOA adoption[26] but do not assess the *maturity* of an organization's overall SOA. In addition, while various frameworks for assessing SOA maturity were developed in the recent years (e.g., Arsanjani and Holley 2005; Hirschheim et al. 2010; Rathfelder and Groenda 2008; Söderström and Meier 2007) none of these have been operationalized for use in empirical research. In particular, ready-to-use items and scales for evaluating the particular maturity level of an organization are absent. According to a Gartner survey (Sholler and Schulte 2009, p. 1) "companies at higher levels of SOA maturity achieved payback faster, realized higher degrees of developer productivity, agility and innovation, and had higher degrees of asset reuse." Thus, SOA is not just a technology fad, but can indeed deliver the promised benefits. However, organizations should focus more on increasing SOA maturity in order to realize the benefits which they expect from adopting SOA.

[26] For example, Kumar et al. (2007) measure SOA adoption with three dummy items whether a firm uses XML, Web Services technologies (SOAP etc.), and a companywide services based IT architecture.

In the following, we will develop an instrument allowing researchers to measure the level of SOA maturity – not simply adoption. Therefore, our goal is not to develop another SOA maturity framework but to add an empirical instrument to existing ones. Concretely, we will operationalize *The Open Group Service Integration Maturity Model* (OSIMM) (The Open Group 2009)) to make it applicable to empirical survey-based research. Our research question is: *How can the maturity of an organization's SOA implementation be measured, classified and made comparable in empirical studies?*

Next, we give an overview of SOA maturity models existing in the literature to then develop an instrument for measuring SOA maturity based on the OSIMM. Finally, we demonstrate its empirical applicability in the context of SOA business value research using survey data from 121 firms.

2 Overview of SOA Maturity Models

One of the best-known generic maturity models is the Capability Maturity Model Integration (CMMI), which extends the previous CMM and defines five levels of process maturity: initial, managed, defined, quantitatively managed, and optimizing. Because of its wide applicability in the industry, the five CMMI-levels often serve as a basis for other maturity models, such as the SOA maturity models which researchers[27] have developed for describing different levels of SOA maturity. The following overview briefly summarizes the most prominent ones:

Service Integration Maturity Model (SIMM), published by IBM (Arsanjani and Holley 2005), describes seven maturity levels: silo, integrated, componentized, simple services, composite services, virtualized services, and dynamic reconfigurable services. It has a technical focus but also has the advantage of covering the earlier stages of service development which are often neglected by other models.

Combined SOA Maturity Model (CSOAMM), published by Söderström and Meier (2007), combines the SIMM and the industry-driven SOA MM (Sonic Software Corporation et al. 2005). It is not a separate maturity model but shows how SIMM, SOA MM, and CMMI are related. As each of the models has a different number of levels (SIMM (7), SOA MM (6), and CMMI (5)), the aim of CSOAMM is to facilitate the "interpretation and comparison of SOA maturity models" (Söderström and Meier 2007, p. 398).

Independent SOA Maturity Model (iSOAMM): Motivated by their findings that many SOA maturity models are developed by "vendors of SOA products and often used to promote their products" (2008, p. 1), Rathfelder and Groenda propose an independent SOA Maturity Model. The iSOAMM consists of five levels: trial SOA, integrative SOA, administered SOA, cooperative SOA, and on-demand SOA. Moreover, it distinguishes five viewpoints for each maturity level: service architecture, infrastructure, enterprise structure, service development, and governance.

[27] We limit our overview to SOA maturity models developed by researchers in contrast to vendor models (e.g., by Sonic Software, HP, or Oracle) to avoid their "dependency on the respective products" (Rathfelder and Groenda 2008, p. 2). However, we have included IBM's maturity model as it is not only technology independent, but also explicitly includes the very early stages of services. Moreover, it serves as a basis for other maturity models (cf. Hirschheim et al. 2010) and was handed over to The Open Group for further enhancements and published as "The Open Group Service Integration Maturity Model (OSIMM)" (The Open Group 2009).

Thus, the proposed model is very comprehensive and describes various necessary tasks within each viewpoint for achieving each maturity level.

SOA Maturity Model: The SOA Maturity Model (Hirschheim et al. 2010) explicitly adds a business dimension to the SIMM and thereby addresses this shortcoming in the SIMM. However, the authors do not use SIMM's seven maturity levels but limit it to five levels, similarly named to CMMI: initial stage, managed stage, defined stage, quantitatively managed stage, and optimized stage. The disadvantage of this change is that, especially on the lower maturity levels, the seven different levels of the SIMM can distinguish an organization's SOA maturity level more precisely than the SOA Maturity Model with only five maturity levels. However, the SOA Maturity Model assesses each of its maturity levels more comprehensively than the SIMM, which focuses more on technical aspects. Therefore, six dimensions are used to cover the business aspects as well: view of SOA, benefits & metrics, business involvement, methodology, sourcing of services, and governance.

The Open Group Service Integration Maturity Model (OSIMM), developed and approved by The Open Group (2009). IBM has handed over its SIMM to this consortium and stopped continuing development. In fact, the two authors of the original SIMM mapping have joined the development team of the OSIMM. The OSIMM draws on the same seven maturity levels as the SIMM, but adds seven maturity dimensions, which leads to the OSIMM maturity matrix. The maturity dimensions are: business view, governance & organization, methods, applications, architecture, information, and infrastructure & management. The model not only describes each maturity dimension and each maturity level, but also defines 87 mainly open questions, which are thus suited for assessing an organization's maturity level with respect to each maturity dimension by using interviews.

As noted before, these maturity models have not yet been operationalized for surveys, and usable items and scales for evaluating the particular maturity level of an organization do not exist. In order to operationalize SOA maturity, we will draw on the OSIMM. The OSIMM has the advantage of being evolved from the popular SIMM, which is also the foundation for the CSOAMM and the SOA Maturity Model. Also, the OSIMM includes different maturity dimensions which, as also suggested by the iSOAMM and the SOA Maturity Model, overcomes the shortcomings of the SIMM which also has a technical focus. Thus, using the OSIMM allows for the most complete and most detailed assessment of SOA maturity considering both business and IT aspects as well as comparing the maturity along different dimensions.

3 Operationalizing SOA Maturity for Empirical Research

For assessing which of OSIMM's seven maturity levels has been reached by a firm, we adopt an approach used by Sabherwal and Chan (2001) for classifying companies according to their corresponding business strategy type. For each organization, we calculate the squared statistical distance to each of the seven maturity levels using the characteristic values of 21 items, which capture the theoretical profiles of the seven maturity levels, in order to categorize an organization regarding its respective SOA maturity level to which it shows the lowest squared statistical distance[28]. Overall, the development of our SOA maturity instrument follows three steps, which are summarized in Figure 1 and described below in greater detail.

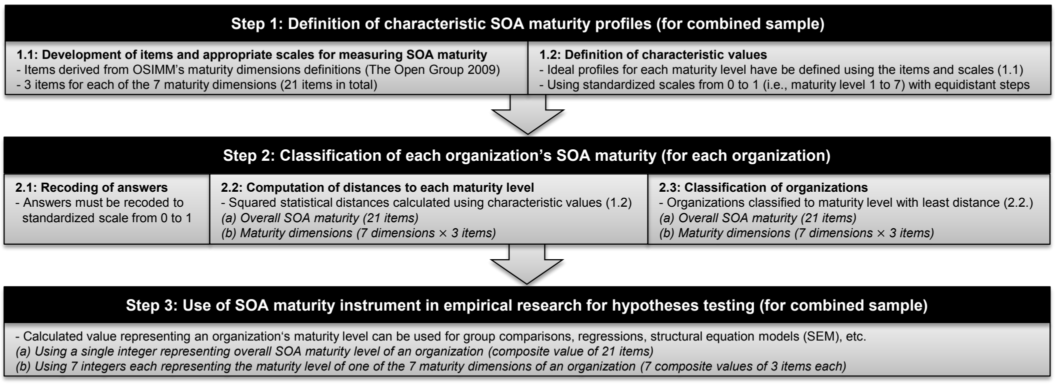

Figure 1. Analytical approach used for operationalizing SOA maturity

Step 1: Definition of characteristic SOA maturity profiles

1.1 **Development of items and appropriate scales for measuring SOA maturity:** The items presented in Table 2 are derived primarily from the definitions given regarding the assessment of each dimension's maturity by the OSIMM (The Open Group 2009) (Table 1) and in addition guided by further details available from The Open Group (2009) such as the OSIMM maturity matrix. As a result, three different items have been developed for each maturity dimension to measure the particular dimension, resulting in a total of 21 items (3 items per dimension × 7 dimensions) for measuring the overall SOA maturity[29].

1.2 **Definition of characteristic values:** For each item, the threshold values (based on a standardized scale from 0 to 1) determining the ideal profile for each maturity level must be defined. These characteristic values x_{li} for all maturity levels l and all items i are always increasing linearly and in equal distance (Level 1: x_{1i}= .00, Level 2: x_{2i}= .17, Level 3: x_{3i}= .33, Level 4: x_{4i}= .50, Level 5: x_{5i}= .67, Level 6: x_{6i}= .83, Level 7: x_{7i}= 1.00). The only exception is the first item measuring the architecture dimension ("We solely use standard software."), which is reverse coded (Level 1: x_{1i}= 1.00 to Level 7: x_{7i}= .00) but uses the same linear steps. To simplify the measurement, we assume equidistant steps for an incremental implementation of all characteristics and consequently define lower characteristic values at the earlier maturity levels in order to reflect limited

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28 We refrain from using cluster analysis as we want to determine the maturity level with respect to already given maturity models and not to cluster organizations into groups, which would not necessarily match with any maturity model levels.

29 We had to make some minor decisions regarding ambiguous items. For example, the definition regarding the application dimension not only covers those applications based on SOA principles, but also using service-enabled technologies (e.g., Web Services, service bus, service registries). As the OSIMM maturity matrix, for example, lists "project based SOA environment" and "common SOA environment" as characteristics of maturity level 4 and 5 of the infrastructure & management dimension, we decided to assign the use of supporting technologies to other dimensions, where the technologies fit better. Finally, we integrated another item (i.e., "extent of business processes supported by SOA") to the application dimension to measure "process integration via service", which characterizes level 6 of the application dimension.

experiences and higher characteristic values at later maturity levels (and vice versa for the reverse coded item).

Step 2: Classification of an organization's SOA maturity

2.1. **Recoding of answers:** The answers of every participating organization must be recoded to the standardized scale (0 to 1) with equidistant steps.

2.2. **Computation of distances of each organization's SOA to each maturity level:** In this step the distance between an organization's SOA maturity and the defined characteristic values for each of the seven SOA maturity levels has to be computed. Therefore, the statistical distance between the answers given to the 21 items (recoded to range from 0 to 1, cf. step 2.1) and the defined characteristic values of each of the seven maturity levels (cf. step 1.2) is computed. We used the statistical distance (Sharma 2008, p. 44) as "the euclidean distance must be adjusted to take into account the variance of the variable" (2008, p. 43). This takes into account that the distribution among variables may vary and that those variables with the same absolute difference are statistically closer, if their variance is larger. The squared statistical distance, $SSD_k^2(Level\ l)$, of a particular organization k to a specific SOA maturity level l is the sum of the differences between the answers of the organization to specific items i, x_{ki}, and the characteristic values for those items for the specific maturity level, x_{li}, weighted by the standard deviation of that item s_i:

$$SSD_k^2(Level\ l) = \sum_{i=1}^{21} \left(\frac{x_{ki} - x_{li}}{s_i} \right)^2$$

At the end, for each organization k seven squared statistical distances have to be computed – one for each SOA maturity level l with the respective characteristic maturity level values x_{li}.

2.3. **Classification of organizations:** Next, each organization can be classified according to one of the seven maturity levels. Comparing the seven values for the squared statistical distance, $SSD_k^2(Level\ l)$, for each organization k, the organization's SOA maturity level will be classified conservatively as the one with the least statistical distance to the characteristic values for the particular maturity level as computed in step 2.2:

$$SOA\ maturity\ level_k = \min_{1 \le l \le 7} (SSD_k^2(Level\ l))$$

Step 3: Use of SOA maturity instrument in empirical research for hypotheses testing: Finally, this leads to the new composite value representing the level of SOA maturity of a particular organization k as a single integer value ranging from 1 to 7.[30]

This new instrument can be used in empirical research which requires the level of an organization's SOA maturity as part of the research model, for example in the area of SOA business value. The new variable can be used for group comparisons, but also as a single item for measuring a latent variable in regressions or structural equation modeling (SEM) and other statistics. The fol-

[30] Alternatively to the determination and classification of organizations with respect to their overall SOA maturity level in steps 2.2 and 2.3, one can conduct both steps iteratively using the three items of each of the maturity dimensions. This would not result in a single integer for the overall SOA maturity level, but in seven integer values representing the level of each maturity dimension of an organization for step 3.

lowing section will give examples for using the derived variable (i.e., SOA maturity) in PLS and other statistics.

Maturity Dimensions	Level 1 Silo	Level 2 Integrated	Level 3 Componentized	Level 4 Services	Level 5 Composite Services	Level 6 Virtualized Services	Level 7 Dynamically Re-Configurable Services
Business View	"… by identifying *the formal definition and documentation of the organization's business drivers and processes*." (p. 16)						
Governance & Organization	"… by identifying *the formal use of service and SOA governance across the organization to develop, deploy, and manage business and IT services (SOA solutions)*." (p. 20)						
Methods	"…by identifying *the formal use of an SOA architectural design, construction, and deployment methodology for the implementation of SOA services*." (p. 25)						
Applications	"… by identifying *the application architectures that are designed and implemented using SOA principles and development practices and utilize constructs such as loose-coupling, separation of concerns, and employ the use of service-enabled technologies such as XML, web services, service bus, service registries, and virtualization*." (p. 30)						
Architecture	"… by identifying *those service components that have been designed and are deployed using formal SOA methods, principles, patterns, frameworks, or techniques*." (p. 36)						
Information	"… by identifying *the information architecture that supports a master data model (federated data service) and implements a common business data vocabulary*." (p. 40)						
Infrastructure & Management	"…by identifying *the IT infrastructure that supports the non-functional and operational requirements and SLAs needed to operate an SOA environment.*" (p. 45)						

Table 1. How each dimension's maturity is assessed using the OSIMM (The Open Group 2009)

Maturity Dimensions								
Business View	**Gov. & Org.**	**Methods**	**Applications**	**Architecture**	**Information**	**Infra. & Mgmt.**	**Item**	**Scale**
X							Services are the primary concept for structuring the non-technical level.	Likert scale from completely disagree to fully agree
X							Redundant business activities have been consolidated.	
	X						Business units are collaboratively identifying business services.	
	X						We have clearly defined processes to pool the IT requirements of the different business units.	
		X					We follow a service-oriented perspective when modeling business activities.	
		X					For designing interfaces we use functional standards (process, functional, data models).	
			X				Exchanging or modifying single components does not affect our IT infrastructure.	
			X				All of our applications are integrated via service-oriented interfaces.	
			X				To what extent are the following business processes supported by SOA? • production/operations • procurement/B2B integration • research & development • marketing/sales/customer relations • secondary processes (accounting, HR etc.) (*average of these five items used as a single item*)	Likert scale from “no SOA” to “solely supported by SOA”
				X			We solely use standard software.	Likert scale from completely disagree to fully agree
				X			Our firm has realized its IT architecture in an SOA-oriented manner.	
				X			Service orientation is the primary design principle of our IT architecture.	
					X		We can easily create consolidated views about all data belonging to a customer.	
							To what extent are the following technologies used in your organization?	
						X	Web Services (WSDL, SOAP)	6 steps (scale: not known or not applied, pilot usage, single projects, particular business area, multiple business areas, firm wide)
						X	Enterprise service bus (ESB) or other service-related bus	
						X	Registry / repository	
X							Business activity monitoring (BAM)	
	X						Business rules engines	
		X					Service-orchestration (e.g., business process execution language (BPEL))	
					X		XML	
					X		Service component architecture (SCA) or service data objects (SDO)	
Note: “X” indicates that the particular maturity dimension of the OSIMM is assessed by the respective item of the instrument.								

Table 2. SOA maturity instrument

4 Exemplary Empirical Application of the SOA Maturity Instrument

This section shows an exemplary empirical application of the new SOA maturity instrument, using data collected from 124 managers responsible for the IT architecture in their organization (chief IT architects, CIOs, or similar). All organizations represent firms operating in the German service industry. First, we conducted the two steps described in the previous section to achieve SOA maturity scores for each firm. In the following, we use this score in an empirical research model for assessing the business value (such as increased business agility or reduced IT costs) with respect to the different levels of SOA maturity.

Figure 2 gives an overview of the descriptive results for the second step (i.e., classification of each organization's SOA maturity). None of the 124 organizations can be classified according to the highest maturity levels 6 or 7. This is not surprising given the fact that we investigate a relatively new concept. For example, early studies investigating the process maturity of software engineering practices according to CMM have only included organizations belonging to level 2 to 4 (Dekleva and Drehmer 1997) or 1 to 3 (Herbsleb et al. 1997). In addition, a survey investigating the project management maturity of 126 organizations reveals a median level of only 2 out of 5 (Grant and Pennypacker 2006). However, we can see a rather broad distribution across maturity levels 2 to 4. Second, we can observe that organizations operating in ICT or financial services tend to have more mature SOAs than other service industries. For example, over 70% of the organizations belonging to these two industry types have an SOA classified at maturity level 3 or higher.

	Trade and logistics	Energy	Financial services	IT and communi-cations	Manag./ business services	Other Services	Total number
Level 7	0%	0%	0%	0%	0%	0%	0
Level 6	0%	0%	0%	0%	0%	0%	0
Level 5	2%	0%	5%	0%	0%	0%	2
Level 4	7%	0%	32%	31%	22%	6%	20
Level 3	44%	67%	41%	46%	35%	41%	53
Level 2	47%	33%	23%	23%	43%	47%	48
Level 1	0%	0%	0%	0%	0%	6%	1
Total number	43	6	22	13	23	17	124

Figure 2. Maturity levels across participants with respect to their industry types

Figure 3 presents the results of alternatively assessing each dimension's maturity level separately instead of assessing the overall SOA maturity level in steps 2.2 and 2.3. The upper figure reveals the spread among the different maturity dimensions in comparison to the overall SOA maturity. The lower figure results from a two-stage cluster analysis approach combining hierarchical and non-hierarchical clustering methods (Malhotra et al. 2005). This figure presents the overall SOA maturity as well as the maturity of each dimension of the five identified clusters. The clusters represent an increasing level of overall SOA maturity from cluster 1 to 5. Even though most firms show more or less balanced maturity levels across the different dimensions, some deviations can be identified. For example, Cluster 4 shows a very high architecture maturity while at the same time having a slightly lower maturity of the business view. Thus, we can see that the overall SOA maturity reflects the maturity of the different dimensions very well.

	Overall SOA Maturity	Applications	Architecture	Business View	Governance & Organization	Information	Infrastructure & Management	Methods
Level 7	0%	0%	1%	0%	0%	1%	0%	0%
Level 6	0%	1%	6%	3%	2%	0%	3%	0%
Level 5	2%	2%	14%	7%	9%	5%	6%	3%
Level 4	16%	22%	23%	18%	19%	6%	22%	10%
Level 3	43%	27%	35%	31%	41%	36%	16%	26%
Level 2	39%	39%	19%	31%	23%	45%	28%	44%
Level 1	1%	9%	3%	10%	6%	7%	25%	16%

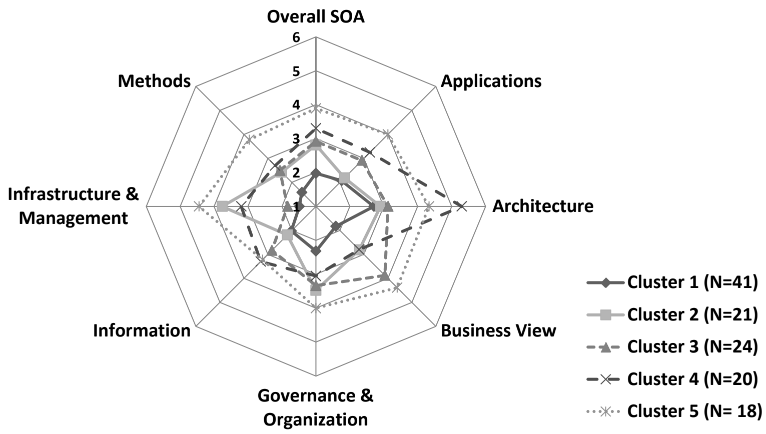

Figure 3. Comparison of overall SOA maturity level with each dimension's maturity

As an exemplary application, we used the level of SOA maturity[31] as exogenous single item construct in PLS[32] in order to investigate the role of SOA maturity on the business value achieved from SOA. Therefore, we assessed the effect of an organization's SOA maturity on three common benefits which organizations look to achieve when introducing SOA (Baskerville et al. 2005; Yoon and Carter 2007): (1) *Increasing business agility* in terms of a "quick IT response to market change or customer demand" (Yoon and Carter 2007, p. 6), (2) *Improving straight through processing (STP)* as it is "easier to integrate systems" (Yoon and Carter 2007, p. 6), which reduces the discontinuities of business processes, and (3) *reduced IT costs* due to "lower application development costs/time" or "lower operational costs" (Yoon and Carter 2007, p. 6). Besides the new variable representing the maturity of an organization's SOA, the other latent variables are measured using reflective multi-item instruments (Table 3).

Construct	Label	Indicator (scales: 7-step Likert scale from "fully disagree" to "fully agree")	Loadings
SOA maturity	SOM1	*SOA maturity based on 21 items as developed before. (scale: maturity level 1 to 7)*	1.000**
IT cost reduction	COR1	All potentials to optimize our IT operating costs were exploited.	.898**
	COR2	All potentials to reduce our software development costs were exploited.	.860**
	COR3	All potentials to optimize our IT management costs were exploited.	.817**
	COR4	The functionalities of our application systems are free from unnecessary redundancies.	.724**
	COR5	Business processes are not implemented multiple times in our organization.	.757**
Agility		Our IT enables our organization, …	
	AGI1	… to flexibly adapt products / services to single customers.	.735**
	AGI2	… to change our product / service offerings faster than our competitors.	.896**
	AGI3	… to realize a shorter time-to-market than our competitors.	.914**
	AGI4	… to react quickly and flexibly to changes in customer demand.	.890**
STP	STP1	Our users are frequently required to re-enter the same data. (*reverse coded*)	.616**
	STP2	All of our applications are integrated, as long as reasonable from a business process perspective.	.895**
	STP3	The activities of our business units are integrated well.	.872**
Note: ** all loadings are significant at $p \leq .01$; indicators are translated from German			

Table 3. Measurement instruments for variables

[31] As only three organizations are classified as having an SOA maturity level 1 or 5, we only used the data from the 121 organizations belonging to SOA maturity levels 2 to 4.

[32] SmartPLS 2.0 (M3) Beta (Ringle et al. 2007) was used.

With the exception of STP1 (.616) all items have loadings exceeding .707 (Nunnally 1978) (Table 3). However, the loading of STP1 is still larger than .6 (Bagozzi and Yi 1988). Regarding construct reliability and convergent validity, we found that all composite reliabilities (C.R.) are higher than .84, which is well above the requested .7 (Nunnally 1978). The minimum AVE across all constructs is .632, which fulfills the demanded .5 by Chin (1998) (Table 4). Moreover, the square roots of the AVEs are in all cases larger than the correlations among the constructs (Gefen et al. 2000) (Table 4) and the cross-loadings of the indicators are lower than their loadings on their own construct (i.e., sufficient discriminant validity) (Table 5).

	C. R.	AVE	1	2	3	4
1 - SOA maturity	1.000	1.000	1.000			
2 - IT cost reduction	.895	.632	.283	.795		
3 - Agility	.920	.743	.248	.281	.862	
4 - STP	.841	.644	.361	.546	.366	.802

Table 4. Convergent validity and reliability as well as discriminant validity of model constructs (diagonal cells contain the square root of AVE)

	SOM1	COR1	COR2	COR3	COR4	COR5	AGI1	AGI2	AGI3	AGI4	STP1	STP2	STP3
SOA maturity	1.000	.275	.215	.250	.126	.206	.153	.176	.243	.255	.197	.339	.312
IT cost reduction	.283	.810	.860	.817	.724	.757	.095	.196	.317	.297	.394	.449	.479
Agility	.248	.176	.244	.194	.338	.239	.735	.896	.914	.890	.215	.310	.343
STP	.361	.367	.468	.327	.525	.578	.121	.331	.379	.370	.616	.891	.872

Table 5. Discriminant validity - crossloadings of indicators

Applying the Kolmogorov-Smirnov test does reveal no significant differences between the participants regarding *non-response bias* (Armstrong and Overton 1977). Further, using the marker variable approach for testing the effect of a possible *common method bias (CMB)* (Podsakoff et al. 2003) shows no structural differences using a theoretically unrelated marker variable[33] as proxy for a common method factor: all levels of significance (loadings and paths) remain the same, and the largest absolute change in R^2 is .018, i.e., negligible.

The results of our exemplary application lead to the path coefficients, significance levels, and R-squares as shown in Figure 4. One can clearly see that the level of SOA maturity has a very strong and highly significant effect on all three of the aspects of SOA business value. However, SOA maturity does not explain a major proportion of their variance (6.2% to 13.0%) as these aspects are also heavily influenced by many other IT-related and organizational factors.

[33] "IT should facilitate access to new markets and regions." (Rated on a 7-Likert scale from "no aim" to "most important aim".)

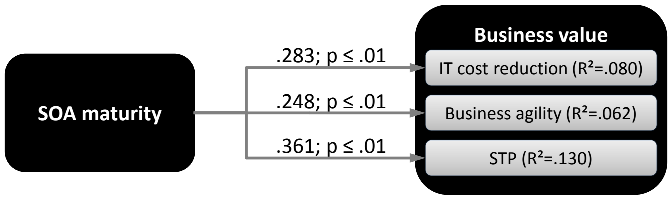

Figure 4. Exemplary application of the SOA maturity instrument in SEM

As the scale of the independent latent variable can be interpreted directly so that by increasing this variable by one unit represents an increase of SOA maturity by one level in the OSIMM, Figure 5 presents the average scores of the three latent business value variables for each level of SOA maturity. The figure shows that the three business dimensions (business agility, STP, and reduced IT costs) rise with increasing levels of SOA maturity. In addition, the figure also indicates decreasing marginal benefits of higher levels of SOA maturity for STP as well as stagnation for business agility from level 3 to 4.

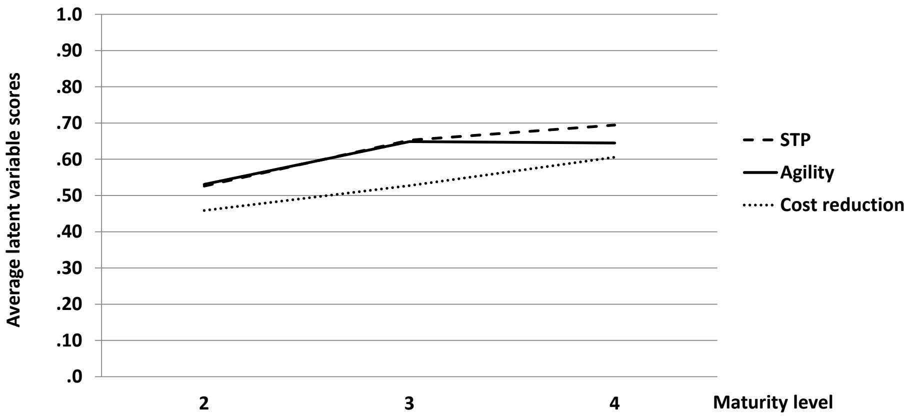

Figure 5. Average latent variable scores with respect to achieved maturity level

5 Conclusion and Further Research

We have developed an analytical approach to classifying organizations with respect to their achieved level of SOA maturity, which can be used in future quantitative SOA research. For each of the seven maturity dimensions defined in the *OSIMM* we developed three items, leading to a total of 21 items as well as characteristic values representing ideal profiles for each of the seven SOA maturity levels. This SOA maturity measurement instrument can be used easily in future survey-based studies. Moreover, in addition to assessing the overall SOA maturity, the presented measurement instrument can also be used to assess the maturity level of each of the seven maturity dimensions separately. Thus, we provide the first operationalization of SOA maturity and its dimensions for survey-based research.

One of the limitations is that the data used for the exemplary application of our instrument stems from a single key informant. Even though the tests for detecting common method bias do not indicate that CMB is a problem, gathering data from different respondents would be the ideal approach. Another limitation is that we have derived the items primarily using the definitions of the seven maturity dimensions as presented in the documentation of the OSIMM (The Open Group 2009). However, one could also extend the operationalization of the measurement instrument for SOA maturity by assessing the entire OSIMM maturity matrix consisting of 49 different characteristics (7 maturity levels × 7 maturity dimensions). We have refrained from this approach as it would greatly increase the complexity of the instrument. If one wants to assess the 49 different characteristics with at least 3 items, as we did for each of the seven maturity dimensions, this would require 147 items. Thus, another, more practical alternative would be to derive the key characteristics not from the maturity dimensions but from the maturity levels (cf. Dekleva and Drehmer 1997). This would match the complexity that our instrument has, but it would not allow the determination of different levels of maturity with respect to each maturity dimension. Finally, instead of assuming equidistant steps for each item from one level to another, one could adjust the size of the steps to reflect the varying importance of the items for the different maturity levels.

6 Contribution

The main contribution of this paper is the operationalization of an already existing SOA maturity model (i.e., OSIMM) for measuring SOA maturity in quantitative research. Even though different conceptual maturity models for SOA have been proposed in the literature, ready-to-use items for survey-based research are not available for any of them. Thus, SOA researchers (e.g., investigating the business value of SOA or of a more mature SOA) can now use the developed and tested instrument and apply the 21 SOA maturity items in their own survey-based research. Using the developed instrument for measuring SOA maturity not only allows the assessment of an organization's overall SOA maturity, but also the maturity of each of OSIMM's 7 subdimensions (business view, governance & organization, methods, applications, architecture, information, and infrastructure & management) to support more detailed and differential analyses on SOA maturity (and the related outcomes).

Furthermore, the exemplary application of the developed SOA maturity instrument offers other SOA researchers a suggestion as to apply this instrument in their research. We have shown the results from 121 organizations which gain new insights into SOA's business value, such as diminishing marginal utility of increasing SOA maturity. Thus, this approach of assessing SOA maturity can serve as a foundation for determining the optimal level of SOA maturity for an organization. This might also be an important additional factor in research on service strategies (Cheng et al. 2006) or SOA's benefits for mass customization (Dietrich et al. 2007). The decreasing function of SOA benefits could be linked to functions of costs and risks associated with varying degrees of SOA maturity. The resulting decision model could support managers in determining the ideal level of SOA maturity. Also, the developed measurement instrument can be used to monitor the development of SOA maturity among a single industry or to compare the maturity levels between different industries. Moreover, it might be possible to identify certain maturity levels as being difficult to realize, e.g. many organizations are quickly moving towards maturity level 4, but higher levels are far from being reached. For such an analysis, the more detailed investigation of the maturity levels of each dimensions might be interesting, as, for example, achieving a higher level of maturity might be more difficult with regards to some dimensions than to others. Such an observation could help answer the question whether firms (a) are satisfied with the achieved maturity level because the benefits achievable with higher maturity levels would not outweigh the related costs (e.g., for educating and training IT staff, implementing technical infrastructure, and adapting organizational and decision-making structures) and risks (e.g., performance risks, implementation risks), or (b) do they try to achieve a higher degree of maturity, but are unable to establish them. In the latter case, subsequent research needs to shed more light on SOA governance to identify those issues that hamper the achievement of higher levels of overall SOA maturity, or specific mechanisms for particular maturity dimensions. Is this, for instance, only a matter of available capital, or are other factors, such as clearly defined processes for service-management, clear directives for using standards, or IT/business alignment missing, also impeding the road to a more mature SOA in an organization?

Thus, the results of such research through the application of the newly developed instrument, would not only shed more light on IT value (i.e., What business value results from different mature SOAs?) but also support managers in their decisions as to which particular tasks are necessary and meaningful for achieving a specific level of SOA maturity (i.e., How can SOA governance support implementing mature SOAs?).

7 References

Armstrong, J.S. and Overton, T.S. 1977. "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research* (14:3), pp. 396–402.

Arsanjani, A. and Holley, K. 2005. "Increase flexibility with the service integration maturity model (SIMM): Maturity, adoption, and transformation to SOA". retrieved 04/30/2010, from http://www.ibm.com/developerworks/webservices/library/ws-soa-simm/.

Bagozzi, R.P. and Yi, Y. 1988. "On the evaluation of structural equation models", *Journal of the Academy of Marketing Science* (16:1), pp. 74–94.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Cheng, H.K., Tang, Q.C., and Zhao, J.L. 2006. "Web services and service-oriented application provisioning an analytical study of application service strategies", *IEEE Transactions on Engineering Management* (53:4), pp. 520–533.

Chin, W.W. 1998. "The partial least square approach to structural equation modeling", in: *Modern methods for business research,* G.A. Marcoulides (ed.). Mahwah, NJ, USA: Lawrence Erlbaum Associates, pp. 295–336.

Dekleva, S. and Drehmer, D. 1997. "Measuring software engineering evolution: A rasch calibration", *Information Systems Research* (8:1), pp. 95–104.

Dietrich, A.J., Kirn, S., and Sugumaran, V. 2007. "A service-oriented architecture for mass customization - a shoe industry case study", *IEEE Transactions on Engineering Management* (54:1), pp. 190–204.

Gefen, D., Straub, D.W., and Boudreau, M.-C. 2000. "Structural equation modeling and regression: Guidelines for research practice", *Communications of the Association for Information Systems* (4:1), pp. 1–77.

Grant, K.P. and Pennypacker, J.S. 2006. "Project management maturity: An assessment of project management capabilities among and between selected industries", *IEEE Transactions on Engineering Management* (53:1), pp. 59–68.

Heffner, R. 2010. "Insights for CIOs: SOA and beyond", *Forrester Research*.

Herbsleb, J., Zubrow, D., Goldenson, D., Hayes, W., and Paulk, M. 1997. "Software quality and the capability maturity model", *Communications of the ACM* (40:6), pp. 30–40.

Hirschheim, R., Welke, R., and Schwarz, A. 2010. "Service-oriented architecture: Myths, realities, and a maturity model", *MIS Quarterly Executive* (9:1), pp. 37–48.

Joachim, N. 2011. "A literature review of research on service-oriented architectures (SOA): Characteristics, adoption determinants, governance mechanisms, and business impact", in: *Proceedings of the 17th Americas Conference on Information Systems (AMCIS)*. Detroit, MI, USA.

Joachim, N., Beimborn, D., and Weitzel, T. 2011a. "Eine empirische Untersuchung des Wertbeitrages von serviceorientierten Architekturen (SOA)", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Joachim, N., Beimborn, D., and Weitzel, T. 2011b. "An instrument for measuring SOA maturity", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*. Shanghai, China.

Joachim, N., Beimborn, D., and Weitzel, T. 2011c. "SOA-governance für effektive serviceorientierte Architekturen – Eine empirische Studie in der deutschen Dienstleistungswirtschaft", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Joachim, N., Beimborn, D., and Weitzel, T. 2011d. "What are important governance and management mechanisms to achieve IT flexibility in service-oriented architectures (SOA)?: An empirical exploration", in: *Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS)*. Kauai, HI, USA: IEEE Computer Society, pp. 1–10.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007. "SOA and information sharing in supply chain: "How" information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Malhotra, A., Gosain, S., and El Sawy, O.A. 2005. "Absorptive capacity configurations in supply chains: Gearing for partner-enabled market knowledge creation", *MIS Quarterly* (29:1), pp. 145–187.

Nunnally, J.C. 1978. *Psychometric theory*, (2. ed.). New York, NY: McGraw-Hill.

Oh, L.-B., Leong, Y.-X., Teo, H.-H., and Ravichandran, T. 2007. "Service-oriented architecture and organizational integration: An empirical study of IT-enabled sustained competitive advantage", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. 2003. "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Psychology* (88:5), pp. 879–903.

Rathfelder, C. and Groenda, H. 2008. "iSOAMM: An independent SOA maturity model", in: *Distributed applications and interoperable systems*. Berlin, Heidelberg: Springer, pp. 1–15.

Ringle, C.M., Wende, S., and Will, A. 2007. "SmartPLS 2.0 (M3) Beta". Hamburg.

Sabherwal, R. and Chan, Y.E. 2001. "Alignment between business and IS strategies: A study of prospectors, analyzers, and defenders", *Information Systems Research* (12:1), pp. 11–33.

Sharma, S. 2008. *Applied multivariate techniques*, (15 ed.). New York, NY: Wiley.

Sholler, D. and Schulte, W. 2009. "Survey update: The value of SOA", *Gartner Research*.

Söderström, E. and Meier, F. 2007. "Combined SOA maturity model (CSOAMM): Towards a guide for SOA adoption", in: *Enterprise Interoperability II,* R.J. Gonçalves, J.P. Müller, K. Mertins, and M. Zelm (eds.). Springer, pp. 389–400.

Sonic Software Corporation, AmberPoint Inc., BearingPoint Inc, and Systinet Corporation. 2005. "A new service-oriented architecture (SOA) maturity model".

Tafti, A., Mithas, S., and Krishnan, M.S. 2008. "The effects of information technology and service-oriented architectures on joint venture value", in: *Proceedings of the 29th International Conference on Information Systems (ICIS)*. Paris, France.

The Open Group. 2009. "The open group service integration maturity model (OSIMM)", Reading, Berkshire.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

PAPER V

THE JOINT IMPACT OF SERVICE-ORIENTED ARCHITECTURES AND BUSINESS PROCESS MANAGEMENT ON BUSINESS PROCESS QUALITY: AN EMPIRICAL EVALUATION AND COMPARISON

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Abstract

What is the interplay between Business Process Management (BPM) and Service-Oriented Architecture (SOA) in achieving high business process quality? In this paper, we empirically investigate the impact of both SOA and BPM on business process quality in terms of straight-through processing (STP), business-to-business integration, quality control, as well as standardization and consolidation of business processes. For the empirical evaluation of our model, we use the data of 157 German service firms. The results show that the SOA paradigm has still received rather low adoption rates in the industry. However, SOA, BPM, and related information technologies have a direct positive impact on business process quality and the analysis provides evidence for the complementarities of BPM and SOA since interaction effects between them have an additional significant impact on business process quality. Consequently, firms having adopted SOA can more effectively apply BPM.

1 Introduction

Business process management (BPM) combines tools and methods to increase the effectiveness and efficiency of business processes. While it has become a popular approach to gain competitive advantage (Hung 2006), empirical research regarding its value contribution is still sparse, yet necessary (Ho et al. 2009). Moreover, new IT architectural paradigms, such as Service-Oriented Architecture (SOA), are increasingly adopted by firms and offer new opportunities to BPM.

This paper aims at empirically evaluating SOA's potential to leverage the impact of BPM on a firm's process quality and efficiency. Previous research has noted that the "partnership of BPM and SOA has been fruitful by merging the benefits of both sides" (Bajwa et al. 2009, p. 677), however, publications covering both BPM and SOA have been conceptual (e.g., Bajwa et al. 2009; Woodley and Gagnon 2005) or based on experiences of single case studies (e.g., Brahe 2007; Smith and McKeen 2008), so far. Therefore, our paper is among the first to face the "need for more empirical studies in the context of BPM" claimed by Ho et al. (2009, p. 9), after reviewing all 37 BPM journal articles published between 2000 and 2008 in the ten Top IS journals.

The "Business Process Report" survey conducted by IDS Scheer[34] in 2007 with about 130 respondents showed that 52% of the surveyed firms already had implemented an SOA or had planned to implement it in 2007, while only 27% reported that SOA is not of interest for them at all (IDS Scheer 2007). Also, 67% of the participants stated that BPM is an important aspect when introducing SOA, which represents a sharp increase compared to 45% in 2006 (IDS Scheer 2006).

Applying SOA's design principles allows an organization to modularize the functionalities offered by existing information systems, such as ERP, CRM, or legacy systems, in order to define fine-grained loosely coupled services, which can be reused to support different business processes. Thus, BPM is expected to benefit from SOA as many business processes heavily depend on the underlying IT and SOA can enable firms to implement the designed business processes on the IT

[34] IDS Scheer has commissioned Pierre Audoin Consultants (PAC) to evaluate the results of an online survey on potentials and success factors in business process management. The participants were decision makers from both business and IT in German, Austrian, and Swiss organizations across different industry sectors.

layer regardless of the complexity of existing legacy systems. Therefore, BPM and SOA together can support firms in optimizing business processes and reaching superior process quality. Therefore, we address the following research question:

What is the interplay between BPM and SOA when trying to reach high business process quality and how does this interplay affect business process quality?

Investigating the effects on business process quality is important, because "the quality of the enterprise's products and services is a direct reflection of its ability to improve its processes" (Elzinga et al. 1995, p. 119). This is consistent with the claim that total quality management (TQM) as an integrated management philosophy "generates improved products and services, reduced costs, more satisfied customers and employees, and improved bottom line financial performance" (Powell 1995, p. 16).

Drawing on data from firms from the service industry in Germany, we empirically evaluate how BPM and SOA jointly affect business process quality in terms of increased business-to-business (B2B) integration, STP, standardization/consolidation, and quality control. The results show that the adoption of SOA is comparable to the IDS Scheer survey and provide first statistical evidence for a complementary effect of BPM and SOA on business process quality. Moreover, they allow practitioners to identify the most important drivers for process quality and can therefore help to identify key aspects for increasing business process quality when considering BPM, SOA, and the adoption of related technologies.

Before developing our research model, the next section introduces how BPM and SOA are conceptualized in this paper and discusses how they might be interrelated. Afterwards, we develop a research model that links BPM, SOA, and related information technologies (IT) with business process quality. The fourth chapter explains the methodology and provides the quantitative empirical results from evaluating the model with survey data from the German service industry. The paper concludes by discussing the results and the limitations, summarizing the contributions, and highlighting avenues for further research.

2 Basics and Definitions

2.1 Business Process Management

Business process management (BPM) „can be generally viewed as a collection of process improvement efforts that differ in mission, scope and approach" (Ho et al. 2009, p. 2). BPM emerged from business process reengineering (BPR), which is more narrowly focused on "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed" (Hammer and Champy 1993, p. 32). Since the very first papers introduced the business process perspective (e.g., Davenport and Short 1990; Hammer 1990), the BPM paradigm has evolved over time and provoked various definitions:

- Elzinga et al. (1995, p. 119) propose that "business process management (BPM) is a systematic, structured approach to analyze, improve, control, and manage processes with the aim of improving the quality of products and services. BPM is thereby the method by which an enterprise's 'Quality' program (e.g., TQM, TQC, CQI) is carried out."

- According to Zairi (1997, p. 64) “BPM is a structured approach to analyse and continually improve fundamental activities such as manufacturing, marketing, communications and other major elements of a company’s operation”.
- Van der Aalst et al. (2003, p. 4) define BPM as “supporting business processes using methods, techniques, and software to design, enact, control, and analyze operational processes involving humans, organizations, applications, documents and other sources of information“.

The last definition of van der Aalst et al. emphasizes the importance of IT in order to improve business processes and to continually track their performance. In order to address these topics, the majority of the firms (84%) agreed that using IT-based BPM tools is important or very important (IDS Scheer 2007). This is not surprising, because most of the BPM topics are very hard to realize without proper IT support. For example, if IT applications are only capable of performing single activities and thereby supporting only parts of business processes, major disadvantages such as process inefficiencies, media discontinuities, impediments to organizational change, and lack of integration within and between firms may occur (Allweyer 2009, pp. 35-37). Thus, efficient data exchange along a business process within a firm or between two firms is hardly possible without integrated IT serving the business processes. Therefore, IT has to be necessarily considered in BPM.

“Organizations that have used IT to redesign boundary-crossing, customer-driven processes have benefited enormously” (Davenport and Short 1990, p. 11). One benefit from considering the IT in BPM is indicated by the fact that 87% of the respondents of the IDS Scheer survey expect better support of business processes from new SOA-based applications (IDS Scheer 2007). This shows that SOA as new promising IT paradigm is seen as a next step of BPM.

2.2 SOA

The concept of service-oriented architectures is often argued to be a ground-breaking remedy to improve the performance and flexibility of business processes (Papazoglou and Heuvel 2007). But, there is much confusion about a common understanding of what SOA actually is (Viering et al. 2009). The definitions of SOA vary widely from narrow IT focused to holistic definitions including both business and IT:

- According to Krafzig et al. (2005, p. 57) "a Service-Oriented Architecture (SOA) is a software architecture that is based on the key concepts of an application frontend, service, service repository, and service bus".
- By contrast, Bieberstein et al. (2005, p. 5) define SOA as a more holistic concept covering both business and IT as “framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities”.
- In addition, Janssen and Joha (2008, p. 35) define a business perspective on top of SOA, i.e., the Service-Oriented Enterprise (SOE): "The SOE is an enterprise that is modularized in business domains.” This enables the establishment of shared service centers. “New products can be created by orchestrating the services provided by the service centers".

Based on these definitions, we distinguish two layers of service orientation (SO): (1) service-oriented design principles followed on the IT layer (i.e., SOA); and (2) managing services (i.e., encapsulated business activities) on an organizational or business process level (i.e., SOE).

While most of the SOA-related literature has examined the technical aspects associated with this paradigm, yet researchers recently have also started to investigate the impact of SOA on organizations' performance, e.g., conceptualizing the interplay between SOA and BPM (e.g., Bajwa et al. 2009; Woodley and Gagnon 2005), evaluating potential business benefits of SOA in case studies (e.g., Baskerville et al. 2005; Brahe 2007; Smith and McKeen 2008; Yoon and Carter 2007), or focusing on the empirical analysis of particular benefits of SOA, such as organizational integration (Oh et al. 2007) and information sharing in supply chains (Kumar et al. 2007).

3 Model Development

This section develops our research model as presented in Figure 1, where BPM, SO (in terms of SOE and SOA) and Technology are proposed to have a positive impact on business process quality. In particular, we are interested in comparing the exclusive (H1-H3) vs. the joint impact (H4) of BPM, SO and supporting technologies on different dimensions of business process quality.

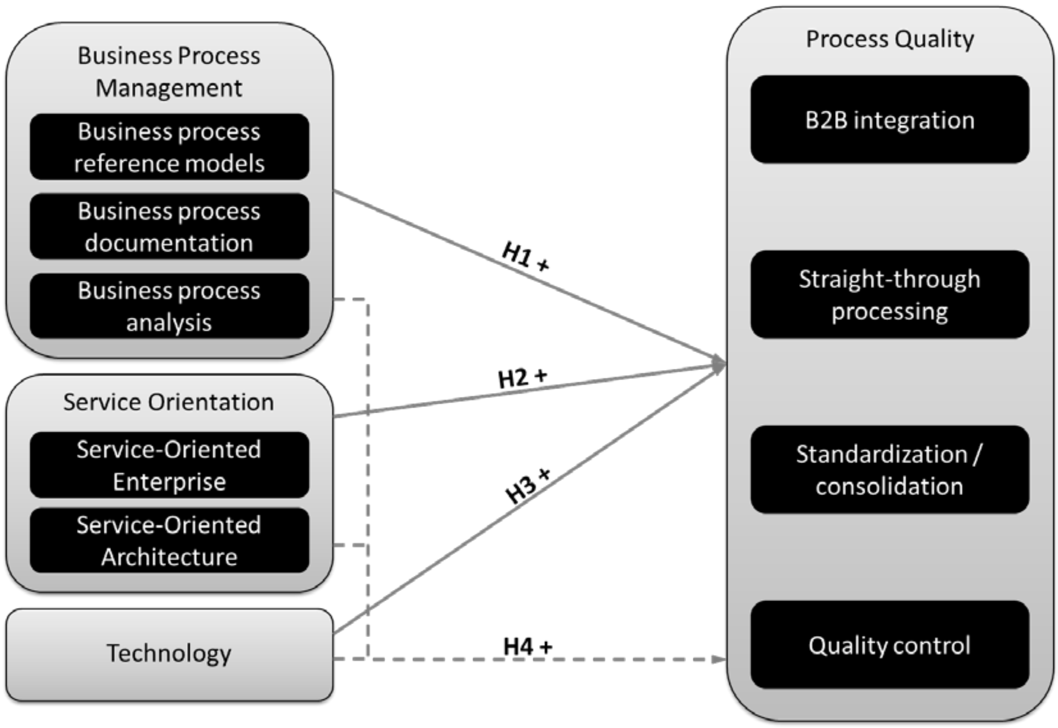

Figure 1. Basic research model

Table 1 gives an overview about all used constructs and their definition.

Construct (abbreviation)	*Definition*	*Source*
Business Process Reference models (BPRM)	Firm-external best-practice blue-prints for designing business processes	(cf. Fettke et al. 2005)
Business process documentation (BPD)	The firm's documentation of its business processes, e.g., in graphical form. "A process document must show clearly the relations between the activities, personnel, information, and the objectives in a given workflow."	(Ungan 2006, p. 138)
Business process analysis (BPA)	BPA covers aspects such as diagnosis and analysis of business processes execution.	(cf. van der Aalst et al. 2003)
Service-Oriented Enterprise (SOE)	"The SOE is an enterprise that is modularized in business domains." This enables the establishment of shared service centers. "New products can be created by orchestrating the services provided by the service centers".	(Janssen and Joha 2008, p. 35)
Service-Oriented Architecture (SOA)	"A service-oriented architecture is a framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities."	(Bieberstein et al. 2005, p. 5)
Technology	Technology covers the related information technologies in terms of tools and standards supporting BPM and SOA.	
B2B integration (B2B)	Business-to-Business integration describes the integration of internal existing processes with trading partners' processes in a manageable manner.	(cf. Tsai et al. 2007)
Straight-through processing (STP)	STP refers to the complete integration of systems along a business process, which enables automation.	(cf. van der Aalst et al. 2003)
Standardization/ consoldidation (CON)	Standardization and consolidation is the goal-directed homog-enization (i.e., reduction of process variants) and realization of economies of scale for process bundling and shared service centers.	(cf. Münstermann and Weitzel 2008)
Quality Control (QCO)	Quality control is "the process for meeting quality goals during operations." This ensures to "conduct […] operations in accordance with the quality plan."	(cf. Juran 1986, p. 21)

Table 1. Definition of used constructs

3.1 Business Process Quality

As the business-relevant dependent variable to be explained by BPM and SOA, our model considers *business process quality*, defined as the adherence to internally established standards with respect to internal and external business process integration, standardization and consolidation. The different components of business process quality are outlined in the following.

For conceptualizing business process quality, we draw on the Juran Trilogy (Juran 1986) which is a popular perspective of total quality management (TQM) (cf. Powell 1995) and consists of (1) quality planning (e.g., set goals), (2) quality control (e.g., evaluate performance), and (3) quality improvement (e.g., establish infrastructure). As the first component of the trilogy, i.e., quality planning, is an antecedent and not a part of business process quality, our dependent variable business process quality draws on (2) and (3) only. Quality control is manifested by the implementation of process monitoring activities. Juran's second dimension of "improvement" is conceptualized in more detail by three further dimensions: *B2B integration*, *straight-through processing (STP)*, and *standardization + consolidation* of business processes. Therefore, our four process quality dimensions cover those two phases of Juran's trilogy which follow the quality planning phase and are therefore expected to sufficiently reflect business process quality. Figure 2 illustrates the relations of these four dimensions. While STP and B2B integration vertically integrate (and thus optimize) business processes within the firm and across its boundaries, process standardization and consolidation remove horizontal inefficiencies by eliminating inferior variants of the same business process and consolidating them to a single processing unit. Finally, the ability to monitor the performance of business processes controls for the effectiveness and efficiency of both the vertical and horizontal optimization over time.

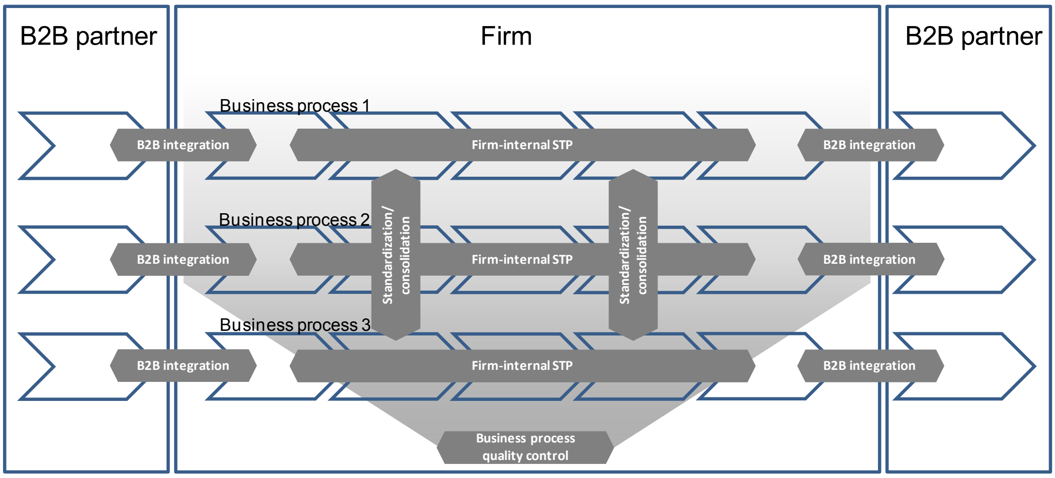

Figure 2. Dimensions of business process quality

Thus, these four dimensions together represent high business process quality from a structural perspective and they are also reflected by topics rated as very important or important in the context of business process management highlighted in the IDS Scheer surveys (cf. Table 2).

BPQ dimension	*Topic*	*2007*	*2006*
CON	Standardization and harmonization of business processes	88%	83%
B2B	Design of B2B processes / collaboration	73%	70%
STP, B2B	Integration of legacy systems	63%	n/a
QCO	Compliance management	57%	67%
QCO	Process performance management	n/a	63%
STP	Introducing systems for process automation	55%	n/a

Table 2. Important topics of business process management (adapted from IDS Scheer 2006; IDS Scheer 2007) ("n/a" signals that the particular topic was not queried in that survey)

STP as well as *B2B integration* are the result of eliminating media discontinuities along a business process (both firm-internal and in B2B) to increase its performance in terms of time, cost, and processing errors (Weitzel et al. 2003). *STP* "refers to the complete automation of a business process" (van der Aalst et al. 2003, p. 1024). For example, if existing legacy systems only support some of the activities needed to perform a particular business process, STP will demand for integrating these systems to enable business process automation. As a consequence of STP, business process performance can be substantially improved. Correspondingly, 63% of the IDS Scheer survey participants rated the "integration of legacy systems" as important issue (IDS Scheer 2007).

Beside firm-internal business process integration, *B2B integration* has become a critical success factor for many firms since inter-organizational relationships and interdependencies usually are an important resource of the firm (Barringer and Harrison 2000) and ensures proper and efficient electronic data exchange and collaboration between partner firms. Correspondingly, around 70% of the respondents of the IDS Scheer surveys rated "design of B2B processes/ collaboration" as (very) important topic of BPM (IDS Scheer 2006; IDS Scheer 2007). This further emphasizes the importance for organizations to integrate their processes with those of their trading partners in a manageable manner (Tsai et al. 2007).

Previous research has shown that *standardization + consolidation* of business processes has a positive impact on business process performance (Münstermann et al. 2009; Sánchez-Rodríguez et al. 2006). This positive impact results from the identification and reduction of process redundancies by consolidating redundant process implementations to a single (optimized) process, and it can additionally benefit from standardizing the consolidated process towards an external reference standard (Münstermann et al. 2009). Correspondingly, more than 80% of the Scheer survey respondents rated “standardization and harmonization of business processes” as a very important or important topic (IDS Scheer 2006; IDS Scheer 2007).

To ensure the performance of the executed business processes, *quality control* plays a critical role. Process standardization + consolidation facilitates quality control as similar activities in different business processes can be compared more easily and more transparently when they are standardized to ensure equality of inputs and outputs of the activities. STP contributes to quality control, as processes without media discontinuities can be more efficiently monitored. Without STP and B2B integration, it is very hard to identify processing bottlenecks since existing media discontinuities between different systems and the necessity to reenter data takes backlog from the system to the staff’s desk and thus hides it from monitoring systems.

An important side aspect of high quality control is to fulfill increasing compliance requirements. Firms have to comply with national and international regulations, e.g., Sarbanes-Oxley Act, International Accounting Standards or Basel II. As many of the compliance issues are located at the business processes level, it is not astonishing that around 60% of the IDS Scheer survey respondents emphasize that compliance management is an important issue of BPM (IDS Scheer 2007).

3.2 Drivers of Process Quality

As outlined above, the research model distinguishes between BPM, SO, and related IT as determinants of business process quality.

For conceptualizing BPM, we consolidated Zairi’s (1997) BPM “rules” into three key aspects, i.e., the use of (1) reference models, (2) business process documentation, and (3) business process analysis.

“BPM relies on systems and documented procedures to ensure discipline, consistency and repeatability of quality performance” (Zairi 1997, p. 65). Therefore, the consistent use of internal or external data, *business process reference models (BPRM)*, such as RosettaNet or ebXML, and data models facilitates well defined interfaces between activities along the business process. The implementation of interfaces which adhere to the same reference model leads to the integration of activities and underlying IT systems and thus enables STP. Moreover, adopting industry-wide accepted reference models facilitates B2B integration. In addition, considering reference models while redesigning business processes is an opportunity to standardize and consolidate them, because existing process variants can be unified with respect to the (industry-wide accepted) reference model. Finally, reference models deliver an excellent foundation for quality control as they usually include checkpoints and reference levels for process performance measures.

As "major activities have to be properly mapped and documented" (Zairi 1997, p. 65), *business process documentation (BPD)* consists of all documents describing the business process including work flows, rules, data, as well as task and decision responsibilities, in order to support BPM. BPD can be seen as an important driver of process quality, as it makes inefficiencies in business processes visible and provides a necessary foundation for any optimization and change activities. Unnecessary media discontinuities can be identified and eliminated much more easily, which helps to establish STP. Similarly, B2B integration is hardly possible when the firms have no documentations regarding the interfaces between their business processes and those of their counterparts. Moreover, standardization + consolidation obviously require documentation of the different process variants in order (a) to identify best of breed and (b) to determine the change requirements to be applied to the other variants. Finally, BPD is also important for quality control as well as for documenting the fulfillment of compliance requirements of business processes for external auditors.

„BPM relies on measurement activity to assess the performance of each individual process, set targets and deliver output levels which can meet corporate objectives" (Zairi 1997, p. 65). *Business process analysis (BPA)* covers those "aspects neglected by traditional workflow products (e.g., diagnosis, simulation, etc.)" (van der Aalst et al. 2003, p. 1023). Diagnosis means analyzing existing business processes in order to identify problems and inefficiencies. Simulation helps to validate new or redesigned processes in order to improve them. BPA reveals inefficiencies, bottlenecks, or media discontinuities, and thus enables process quality improvement such as firm-internal STP and B2B integration. In addition, before standardizing business processes, BPA can be utilized to compare existing processes with the reference process in order to determine whether quality will increase or not. Moreover, results of BPA allow for benchmarking and quality control of the running business processes.

As a conclusion, we can summarize that the different parts of BPM (use of reference models, BPD, and BPA) increase process quality along its four dimensions (STP, B2B integration, standardization + consolidation, quality control).

Hypothesis H1: BPM (in terms of applying reference models, BPD, and BPA) increases the quality of business processes (in terms of STP, B2B integration, standardization + consolidation, and quality control).

Service orientation both on the enterprise layer (SOE) and on the IT layer (SOA) is expected to increase the value of IT in the BPM context and to catalyze the effectiveness of BPM activities by facilitating process analysis, process changes, and integration (Bajwa et al. 2009; Brahe 2007; Woodley and Gagnon 2005). Consequently, 39% of the Scheer survey respondents rated the introduction of SOA as important topic for BPM (IDS Scheer 2006) while only 27% reported that SOA is not of interest for them (IDS Scheer 2007).

SOA follows design principles, such as using standardized service contracts, loose coupling, abstraction, reusability, autonomy, statelessness, discoverability, and composability in order to satisfy the required separation of concerns (Erl 2007). This concept basically argues that substantial problems can be more effectively solved if they are divided into smaller concerns. Thus, consistently applying the design principles of the SOA paradigm on the IT layer will typically result into many modular services instead of a few large applications. As single services (corresponding to small concerns) are easier to manage, business process quality can be more easily improved. For example, STP or B2B integration are more difficult across different legacy systems compared to modular services because services – in contrast to legacy systems – already inherently meet the concept of integration by definition (since a service is obsolete without a service requestor).

Also, standardizing entire business processes or particular subsets is enhanced since common activities can be more easily identified and consolidated. In the case of large legacy systems one has to identify the specific part of a complex system which is responsible for a particular activity.

In addition, modular services with clearly defined responsibilities improve quality control and compliance in contrast to intransparent legacy systems – although one could also reversely argue that a large number of fine-grained services increase management efforts for orchestration and therefore making quality control more complex and difficult, as more services have to be tracked, analyzed, and evaluated instead of a few single systems (Bae and Seo 2007)[35].

However, only when an *SOE* is established, the described potential benefits of SOA on the technical level can be sufficiently exploited. Implementing shared service centers helps to identify varieties in business processes in order to standardize and consolidate business processes. Moreover, services developed and deployed within an SOA should be organized according to the business functionality they belong to in order to further support the identification of redundant implementations of business functionality on the IT level (Janssen 2008). When these conditions are met, organizations are able to manage their service-oriented environment "in such a way that the process is visible and manageable end-to-end" (Brown and Carpenter 2004, p. 347). Thus, STP and B2B integration are reached and quality control is facilitated. However, one could also argue that the separation of business functionality in form of shared services will decrease business process quality because the managerial complexity increases. Without firm-wide realization of SOE, each manager has the full control about the resources necessary to perform the business processes he is responsible for. Instead, when organizations follow the SOE paradigm, managers have to share resources (i.e., shared services), which increases the need for communication and consensus in terms of time, cost, as well as quality with respect to an optimum from a firm-wide perspective – which will not necessarily be optimal for the local manager's particular business processes. Nevertheless, we basically follow the prevailing opinion that service orientation will drive business process quality and propose:

Hypothesis H2: Adopting and implementing the service-oriented paradigm on the organizational level (SOE) and on the IT level (SOA) contributes to the quality of business processes (in terms of STP, B2B integration, standardization + consolidation, and quality control).

While the previous two determinants of process quality focus on the *concepts* of BPM and SO, the third independent variable deals with the related information technologies in terms of tools and standards supporting both BPM and SOA.

Web Services and related standards (e.g., XML, WSDL, UDDI, and SOAP) are often applied when implementing an SOA (Papazoglou and Heuvel 2007). Moreover, for orchestrating services, new standards have evolved to isolate the management of business processes in a separate component, e.g., business process execution language (BPEL) (van der Aalst et al. 2003). In particular, for establishing STP and B2B integration, Web Services and BPEL are expected to be major enablers (Leymann and Roller 2006; Tsai et al. 2007). Thus, the utilization of Web Service-related

[35] In a similar way, one could argue that SOA inhibits STP, B2B integration, and standardization + consolidation instead of facilitating it.

standards, such as XML, WSDL, SOAP, UDDI, or BPEL can improve process quality by offering a way to standardize the technical interfaces between legacy systems and thus to act as enablers for both standardizing business processes as well as integrating them internally and externally (STP and B2B integration). Further, using an enterprise service bus (ESB) improves the ability to switch between different implementations of the same functionality on the IT layer without any change on the business layer. An example would be the decision of the firm to alter its B2B integration configuration due to the outsourcing of certain activities to another organization. In this context, there is no need to alter the entire business process (Oh et al. 2007). Instead, only changes in the ESB or the related service registry or repository are required. Similarly, the central use of a service registry or repository enables an organization to standardize and consolidate its business processes, because similar services can be identified more easily in a central repository.

Further, "Business Activity Management (BAM) is becoming one of the most critical areas to transform a business into an adaptive enterprise" (Jeng et al. 2004, p. 59). Therefore, tools performing data logging, monitoring, and controlling of business activities as well as handling business rules are further drivers for process quality. As explained before, the ability to monitor process quality is essential to continually improve the business processes in terms of STP, B2B integration and to identify differences in their compliance to the expected service level. Also, the explication of business rules into rule engines enhances the ability to standardize business processes, because their underlying rules are visible, and to integrate the processes internally as well as externally, because the important business rules, which have to be satisfied, are easier to monitor.

Hypothesis H3: The use of BPM and SOA related IT contributes to the quality of business processes (in terms of STP, B2B integration, standardization + consolidation, and quality control).

Up to now, our model only considers the single, unrelated influence of BPM, SO, and IT on business process quality. However, the main aim of this paper is to analyze the joint impact in order to identify complementarities. Thus, we further propose a joint positive *interaction effect* of all three constructs together on process quality.

Applying reference models and creating profound process documentation in BPM is a valuable or even necessary input for establishing an effective SOA, as business domains and shared service centers can be arranged in accordance to the used reference models and based on the documentation of the processes. Thus, the services on the IT layer, following service-oriented principles such as sharing and reuse of existing functionality, are more likely to support standardization + consolidation of business processes as the same service can be used whenever the same functionality is needed in different business processes (Beimborn et al. 2009; Heinrich et al. 2009; van der Aalst et al. 2003). In addition, SOA is seen as a way to implement processes, which are designed by BPM tools, more efficiently (Bajwa et al. 2009; Smith and McKeen 2008). Thus, the interplay of SOA and BPM is proposed to promote STP and B2B integration. Further, both SOA and BPM rely on various information technologies, such as BPEL or business rules engines, which benefit from detailed process documentations and using reference models in order to increase the ability to monitor the executed business processes with respect to the desired process execution.

Hypothesis H4: The joint use of SO, BPM and IT enhances business process quality in a complementary manner (i.e., positive interaction effect).

4 Empirical Evidence

4.1 Methodology

For evaluating the research model, we applied a quantitative approach and conducted a survey with 1,615 firms in the German service industry, covering logistics, trade, financial services, energy, research, health and social services, IT and communications, management services, engineering services, business services, and other services (i.e., US SIC codes 4,000 to 8,999). The service industry was chosen because of the comparatively high degree of IT-intense business processes compared to other industries where the importance of physical assets as production factor is much higher.

We called each firm by phone in order to identify the leading IT architect and to request their participation in the survey. This led to 955 personally identified contacts. Afterwards, the data was collected by distributing a paper-based[36] questionnaire. After several reminders (via mail and phone), we eventually received 157 completed questionnaires that could be used for the data analysis (i.e., response rate of 16.4%).

The following diagram provides a descriptive overview about the responding firms. The average firm size of the sample is 6,902 employees and the proportions of different business sectors are quite representative for the German service industry (cf. Figure 3).

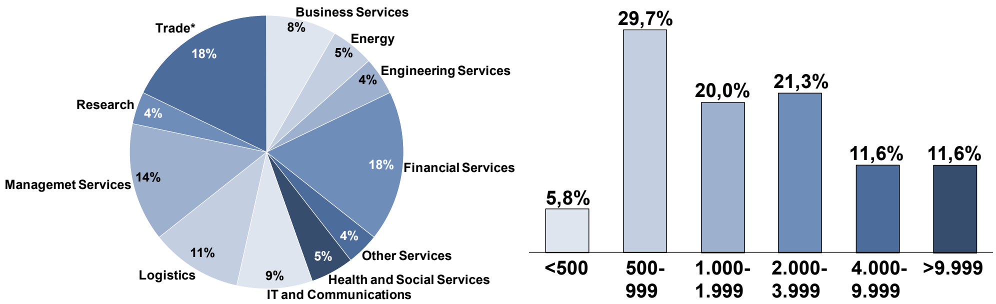

Figure 3. Left: distribution of sectors within the service industry (* some trade firms also manufacture the traded goods); right: distribution firm sizes based on number of employees

The different SOA and BPM related technologies listed in the previous section have still received a rather low degree of adoption in the market (cf. Figure 4). As the following figure shows, many technologies are either not used or only used in pilot projects by many firms. While Web Services are quite frequently used, actual SOA-related technologies such as the enterprise service bus (ESB) and registries are only used by about a third of the surveyed firms in a productive manner. BPM technologies such as business activity monitoring (BAM) or rule engines are applied by every fourth organization while advanced concepts such as business process execution language (BPEL) or service data objects (SDO) / service component architecture (SCA) can only be found to a very low degree.

[36] At the phone, some of the addressees wished to receive their questionnaire by email or fax, which in these cases was respected and sent, accordingly.

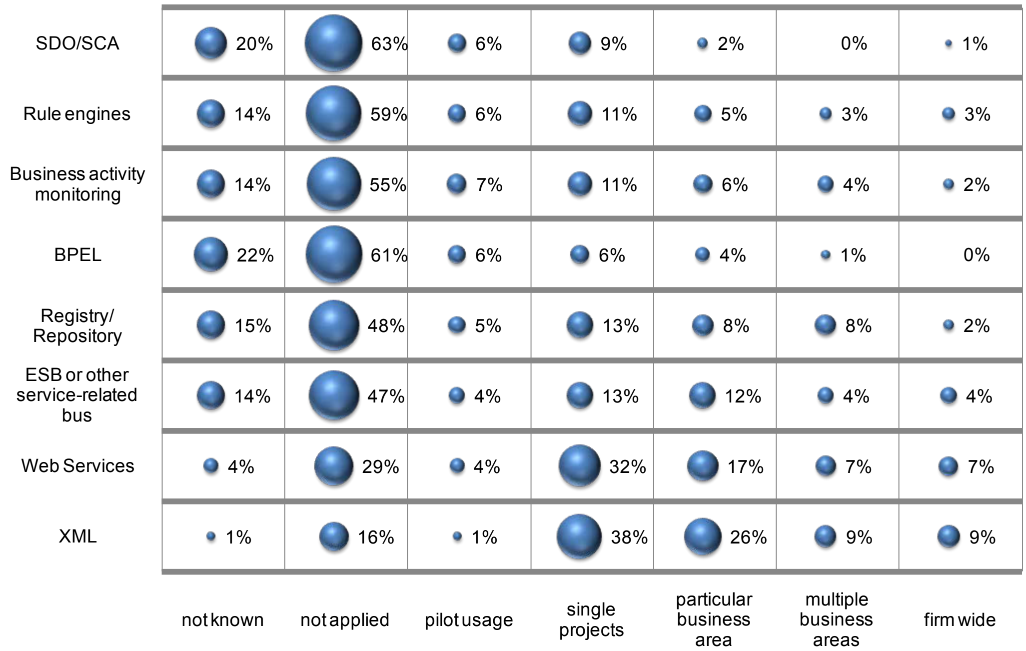

Figure 4. Usage of related information technologies in the BPM and SOA context

For analyzing the data and testing our research model, we used Partial Least Squares (PLS) (SmartPLS 2.0 (M3) Beta (Ringle et al. 2007)) as well as confirmatory factor analyses, regression analyses, and correlation analyses performed by PASW Statistics 17.

All constructs of our research model except one were measured in a reflective way and are represented by two to four indicators which correspond to items in the questionnaire. As specified in the theoretical model, "process quality" is conceptualized by four distinct dimensions. Technology was measured in a formative way, capturing all technologies listed in Figure 4. The following table provides an overview about the operationalization of all constructs, their indicators, and the corresponding scales used.

Construct	Item	Text	Scale[37]
BP reference Models	BPRM1	Our firm uses reference process models (e.g., RosettaNet, ebXML) in order to achieve a high degree of process standardization.	-3 – +3
	BPRM2	For designing interfaces we use functional standards (process, functional, data models).	-3 – +3
BP docu-mentation	BPD1	Documentations of all business processes of our firm are available in a central repository.	-2 – +2
	BPD2	Which proportion of the business processes is completely documented?	0% – 100%
BP analysis	BPA1	All of our business processes have been quantitatively analyzed (processing times, errors, etc.).	-2 – +2
	BPA2	All of our business processes have been monetarily analyzed (process costs).	-2 – +2
SOE adoption	SOE1	We follow a service-oriented perspective when modeling business activities.	-2 – +2
	SOE2	Services are the primary concept for structuring the non-technical level.	-2 – +2
SOA adoption	SOA1	Our firm has realized its IT architecture in an SOA-oriented manner.	-3 – +3
	SOA2	Our IT landscape follows the SOA paradigm as far as possible.	-3 – +3
	SOA3	Service orientation is the primary design principle of our IT architecture.	-3 – +3
	SOA4	All of our applications are integrated via service-oriented interfaces.	-3 – +3
Consolidation	CON1	In our firm, redundant business activities have been identified.	-2 – +2
	CON2	Redundant business activities have been consolidated.	-2 – +2
STP	STP1	Our users are frequently required to re-enter the same data. (reverse coded)	-3 – +3
	STP2	Our IT landscape is characterized by many media discontinuities. (reverse coded)	-3 – +3
	STP3	All of our applications are integrated, as long as reasonable from a business process perspective.	-3 – +3
	STP4	The activities of our business units are integrated well.	-3 – +3
Quality control	QCO1	Operational performance indicators of business processes (e. g., cycle time, errors) are available.	-3 – +3
	QCO2	The transparency of our business processes facilitates compliance.	-3 – +3
B2B integration	B2B1	The business processes of our organization are well integrated with those from our business partners.	-3 – +3
	B2B2	We efficiently exchange data with our business partners.	-3 – +3
	B2B3	Overall, the integration between our business partners and us is high.	-3 – +3
Technology	T1	XML	0 = {not known | not applied | pilot usage}, 1 = {single projects | partic-ular business area}, 2 = {multiple business areas | firm wide}
	T2	Web Services (WSDL, SOAP)	
	T3	ESB or other service-related bus	
	T4	Registry / repository	
	T5	BPEL	
	T6	Business Activity Monitoring (BAM)	
	T7	Business Rules Engines	
	T8	Service Component Architecture (SCA) / Service Data Objects (SDO)	

Table 3. Indicators used in the research models (original items were in German)

[37] SOA-related items were the center of the study. In order to increase the variability within these items, we used 7-point scales. For the other items, we used 5-point scales to reduce complexi-ty from the respondent's perspective (King et al. 2007). According to Dawes (2008), 5-point and 7-point scales produce the same mean scores once they have been rescaled.

4.2 Results

The following results section is structured threefold: in a first step, the goodness of the data used is tested in terms of normality, common method bias, and non-response bias. Moreover, the measurement models' validity and reliability are evaluated. In the second step, we test our proposed research model and finally we analyze the impact of the particular information technologies on the process quality dimensions.

4.2.1 Data Quality and Measurement Model Evaluation

First of all, the data was tested on univariate normality, uncovering slight deviations of kurtosis and skewness from normality. Similarly, the Shapiro-Wilk showed that some of our items are not sufficiently normally distributed. Beside the small size of the data set and the use of formative measures, this was the reason for choosing PLS instead of covariance-based structural equation modeling (SEM) for testing our research model.

For avoiding *common method variance* (CMV) in terms of context bias, we used two questionnaires with different sequences of the questions and we used different scale formats and anchors (cf. Table 3). Further, we tested our data by applying the Harman single factor test, which uncovered that no single component explains the majority of the total variance shared by all indicators, but only between 28.8% and 30.8% across all four models. As a second procedure, we applied the approach suggested in (Liang et al. 2007; Podsakoff et al. 2003). All indicators were transformed to single-item constructs loading both on their own substantive construct and on a latent common method factor composed by all items used in the model. Only two out of 22 paths between the common method factor and the items showed to be (slightly) significant. These findings indicate that CMV is not a severe issue in our data although this problem can never be completely avoided as long as single respondents are requested to provide the whole data.

Third, we analyzed the data regarding *non-response bias*. Comparing the answers given by the early respondents and those that answered after the reminder procedures showed no significant differences for any of the items used according to the Mann-Whitney test and the Kolmogorov-Smirnov test.

When applying data to test a research model by PLS, one needs to ensure that certain criteria regarding validity and reliability of the measurement models are met. Basically, we test four different PLS models – one for every process quality dimension. Furthermore, for testing the interaction hypothesis, we need a basic model variant and an interaction model variant, which includes the interaction terms between BPM, SOA, and technology, in order to compare the R^2 between the two model variants. The following figures show both variants.

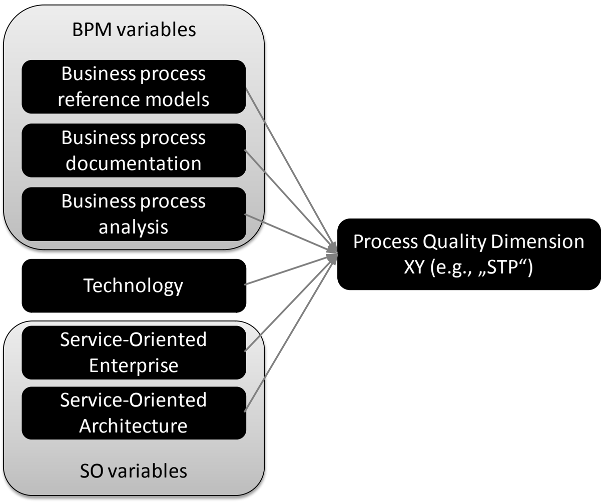

Figure 5: Basic model

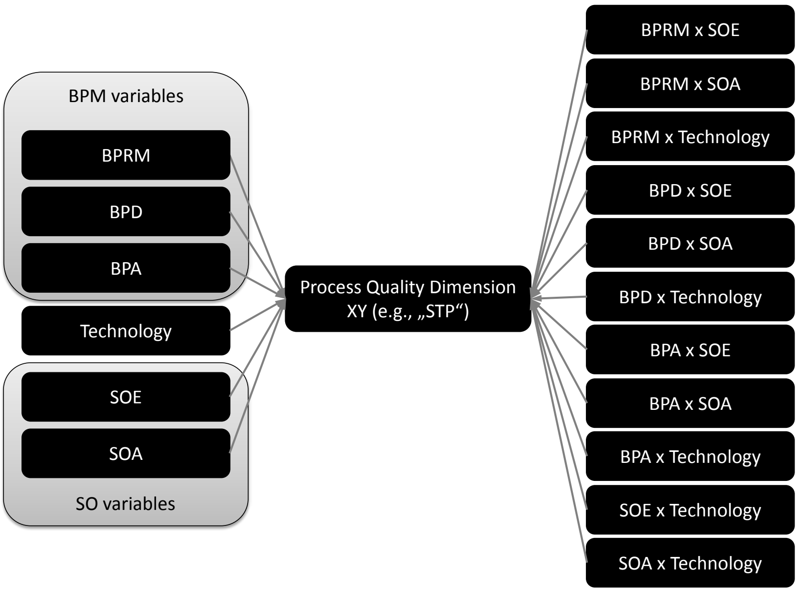

Figure 6. Interaction model

Usually, the loadings of the reflective items are required to be larger than 0.7 (Nunnally 1978), which is fulfilled by all but one case (in one of the four model calculations, one single loading is 0.667 and thus fulfills at least the 0.6 criterion as requested by Bagozzi and Yi (1988); cf. Table 11 in the appendix).

Moreover, the composite reliability (C.R.) is larger than 0.7 for all constructs in all models and the average variance extracted (AVE) is larger than 0.5 in every case. Thus, we can conclude that our measures are sufficiently consistent and are largely explained by their indicators.

Construct	Model "STP"		Model "B2B integration"		Model "Consolidation"		Model "Quality control"	
	AVE	C.R.	AVE	C.R.	AVE	C.R.	AVE	C.R.
BPA	0.792	0.884	0.754	0.857	0.790	0.883	0.789	0.882
BPD	0.839	0.912	0.841	0.913	0.838	0.912	0.837	0.911
BPRM	0.636	0.773	0.641	0.780	0.646	0.785	0.631	0.773
SOE	0.908	0.952	0.895	0.944	0.903	0.949	0.903	0.949
SOA	0.845	0.956	0.840	0.955	0.846	0.956	0.839	0.954
STP	0.623	0.868						
B2B integration			0.873	0.954				
Consolidation					0.700	0.824		
Quality control							0.813	0.897

Table 4. Convergent validity and reliability of model constructs

To ensure that the measures of the different constructs are sufficiently discriminant to each other, the inter-construct correlations need to be lower than the square root of the AVE (Gefen et al. 2000). As the following table shows, this criterion is fulfilled as well. In addition, all indicators have the highest loadings on their associated constructs, while having lower loadings on all other constructs.

	BPA	BPD	BPRM	SOE	SOA	STP	B2B integration	Consolida-tion	Quality control
BPA	0.868								
BPD	0.394	0.915							
BPRM	0.352	0.367	0.794						
SOE	0.319	0.263	0.421	0.946					
SOA	0.306	0.198	0.520	0.544	0.916				
STP	0.331	0.546	0.455	0.314	0.386	0.789			
B2B integration	0.119	0.242	0.240	0.114	0.244	n/a	0.934		
Consolidation	0.364	0.367	0.424	0.395	0.249	n/a	n/a	0.837	
Quality Control	0.521	0.472	0.410	0.272	0.413	n/a	n/a	n/a	0.902

Table 5. Discriminant validity (diagonal cells contain *minimum* square root of AVE across all four models. Remainder contains *maximum* inter-construct correlations across all models)

As a summary, we can conclude that all of the usual quality criteria are fulfilled by our data and our model calculation.

4.2.2 Structural Model: Test of Hypotheses

For testing hypotheses H1 to H3 (i.e., singular effects of BPM, SO, and IT), we calculated the four PLS models outlined before. The following table shows the resulting path coefficients, their levels of significance, and the R^2 of the determined business process quality variables.

Dependent variable:		STP	B2B integration	Quality control	Consolidation
R^2		0.440	0.196	0.447	0.414
BPM (H1)	BP Reference Models	**0.154****	0.027	0.060	**0.189****
	BP Analysis	0.063	0.019	**0.318*****	**0.162*****
	BP Documentation	**0.407*****	**0.195****	**0.275*****	**0.198*****
SO (H2)	SOE	-0.014	-0.100	-0.063	**0.190****
	SOA	**0.139***	0.-091	**0.194****	**-0.182****
(H3)	Technology	**0.208*****	**0.336*****	**0.173****	**0.371*****
N (Sample size after deleting datasets exhibiting missing values)		125	122	121	122

Table 6. Model test results (H1 - H3) (*: p<0.01, **: p<0.05, *: p<0.1)**

As one can see, the proposed model explains substantial parts of the business process (BP) quality variables (R^2 up to 44.7%). While the degree of BP documentation is consistently and positively related to all four BP quality dimensions, the paths from BP analysis are only significant in case of quality control and consolidation. By contrast, the use of BP reference models is positively related to STP and the standardization and consolidation of business processes.

The role of SOA is less clear. While the adoption of a service-oriented paradigm on the IT architecture level is positively related to STP and quality control, it shows a negative impact on consolidation. By contrast, a service-oriented enterprise architecture is positively related with consolidation but has not any impact on the other dimensions of process quality.

By contrast, the relationship between technology and BP quality is very obvious; there are strong and positive path coefficients from it to all process quality dimensions of STP, B2B integration, consolidation, and quality control.

For testing hypothesis 4, we apply an interaction test. Since the model embraces one formative independent variable, the typically used product-indicator approach is not applicable. Instead, we follow the approach suggested in the online appendix of (Chin et al. 2003): first, the model is estimated without interaction terms. Then, the scores of all latent variables are extracted and used as only indicators for estimating the model again, while the cross-products of these scores are used to reflect the interaction terms included in the estimation of this second model (cf. Figure 6). For determining the size of the interaction effect on the BP quality variables, we apply the f^2 formula given by Chin et al., which compares the difference between R^2 of the dependent (BP quality) variable with and without interaction terms included in the model. We use a multi-step approach which adds the different products (BPM variables x SO variables, BPM variables x Technology, SO variables x Technology) stepwise to the basic model. Table 7 summarizes the resulting effects sizes. The level of significance was determined by conducting a pseudo F-test as, e.g., done in Mathieson et al. (2001). To do so, F was calculated by multiplying f^2 with $(n – k – 1)$, where n represents the size of the sample and k the number of parameters to be estimated.

Dependent variable:	STP	B2B integration	Quality control	Consolidation
	Interaction effect size (f^2)			
BPM * SO (6 interaction terms)	**0.035**** ($R^2 = 0.459$)	**0.092***** ($R^2 = 0.264$)	**0.051**** ($R^2 = 0.474$)	**0.034*** ($R^2 = 0.433$)
BPM * Technology (3 interaction terms)	**0.043**** ($R^2 = 0.463$)	0.009 ($R^2 = 0.203$)	0.011 ($R^2 = 0.453$)	0.017 ($R^2 = 0.424$)
SO * Technology (2 interaction terms)	0.018 ($R^2 = 0.450$)	0.002 ($R^2 = 0.198$)	0.007 ($R^2 = 0.451$)	**0.046**** ($R^2 = 0.440$)
BPM*SO + Tech.*BPM + SO*Technology (11 interaction terms)	**0.116***** ($R^2 = 0.498$)	**0.103***** ($R^2 = 0.271$)	**0.082***** ($R^2 = 0.489$)	**0.091***** ($R^2 = 0.463$)

Table 7. Size of effect (f^2) of interaction terms on dependent variables[38] (*: p<0.01, **: p<0.05, *: p<0.1)**

The analysis uncovers some interesting findings. First, the interaction of BPM and SO shows weak but significant positive effects on every process quality dimension. Thus, we can conclude that BPM and SO have a super-additive impact on process quality and thus performance. Second, there is hardly any interplay between BPM and the set of technologies analyzed. Only in the STP-model, where the focus of BPM is massively on (technical) integration, there is a significant interaction effect. Third, the only effect of SO * Technology is on consolidation. This greatly highlights the main benefit of a service-oriented paradigm, i.e., identifying and consolidating redundant activities. Identification is done by a service-oriented view (particularly by the SOE paradigm) while the consolidation needs technology. Finally, when looking at the last row, which considers the aggregate of all interaction effects within one model, we can summarize that there is a verifiable interaction effect between BPM, SO, and the related IT and we can weakly accept hypothesis 4 regarding all process quality dimensions.

Finally, the following table provides the effect sizes of the different concepts. For calculating f^2, we compared the R^2 of the model with and without all variables related with the regarding concept (e.g., for SO: SOE, SOA, SOE*BPRM, SOA*BPRM, SOE*BPA, SOA*BPA, SOE*BPD, SOA*BPD, SOE*Technology, SOA*Technology).

Dependent variable:	STP	B2B integration	Quality control	Consolidation
	Overall effect size (f^2)			
BPM (BPRM + BPA + BPD)	0.530	0.158	0.517	0.298
SO (SOE + SOA)	0.104	0.106	0.114	0.128
Technology	0.149	0.129	0.063	0.248

Table 8. Overall effect sizes of BPM, SO, and Technology on the process quality dimensions

As a summary, this table shows that BPM has the most revealing effect on the different dimensions of process quality while the impact of SO is quite weak but nevertheless existent. From a relative perspective, i.e., if comparing the BPM and SO or technology impacts, consolidation and B2B integration show to be most strongly affected by service orientation and related technology which uncovers the primary benefits of the SO paradigm in the BPM context, i.e., deciding about consolidating redundant business activities and integrating services from third parties. Neverthe-

38 $f^2 = (R^2_{\text{model with interaction term}} - R^2_{\text{model without interaction term}}) / (1 - R^2_{\text{model with interaction term}})$ (Chin et al. 2003; Cohen 1988)

less, SO acts as a pure moderator in the B2B integration context since any direct links were insignificant (cf. Table 6).

4.2.3 Analyzing the Role of Particular Technologies

In a last step, our analysis focuses on the different items of the technology construct. Since this model component was measured in a formative way, the different elements offer opportunities for analyzing the role of technology on a more detailed level. But, as shown in the methodology section above, some of the more sophisticated technologies have not reached a substantial stage of diffusion throughout the market, yet. Consequently, the following analysis has only indicative character for those technologies.

Based on a confirmatory factor analysis, we derived latent variable scores for the four dependent constructs. These were used as dependent variables in multivariate regression analyses with the different technology items used as independent variables. Unfortunately, the non-normal distributions of the different technology items weakened results. Therefore, we decided to test at least for bivariate correlations between the dependent variable scores and the technology items, which are given in the following table.

Dependent variable:	STP	B2B integration	Quality control	Consolidation
Technology variables	Pearson correlation coefficients			
XML	**0.218*** **	**0.282*** **	**0.178** **	**0.305*** **
Web Services	**0.165** **	**0.224*** **	**0.161** **	**0.269*** **
ESB or other service-related bus	0.058	**0.209** **	0.079	**0.175** **
Registry. repository	**0.169** **	**0.237*** **	**0.206** **	**0.156* **
BPEL	0.027	**0.205** **	0.127	**0.145* **
Business Activity Monitoring	0.055	**0.159* **	**0.181** **	**0.219*** **
Rule engines	0.033	**0.159* **	0.081	**0.197** **
SCA or SDO	0.063	0.071	**0.210** **	0.044

Table 9. Correlations between technology items and BP quality (*: p<0.01, **: p<0.05, *: p<0.1)**

Obviously, XML has a strong correlation with any of the BP quality dimensions. Since 1998, it has risen to a major and universal technology which is omnipresent and has a fundamental influence in integration scenarios. Quite similarly, the advent of Web Services, together with service registries/repositories, has contributed to the integration and successful management of business processes. The remaining technologies play a more differentiated role. For example, service busses and related process execution concepts (BPEL and rule engines) are related with process consolidation and B2B integration, but not with firm-internal integration. Finally, the more BPM-related concept of BAM plays a primary role for B2B integration, quality control, and consolidation while the more SOA-related concepts SCA and SDO are only correlated with quality control.

As a summary of the empirical analysis, we can conclude that technology necessarily plays a certain role for reaching efficiently performing business processes, but that it is up to the superior concepts of BPM and SO which by their interplay contribute predominantly to a firm's superior business process configuration and thus to higher organizational performance. The following table summarizes the test results.

Dependent variable:	STP	B2B integration	Quality control	Consolidation
H1 (BPM → BPQ)	partially confirmed (BPA not)	partially confirmed (only BPD)	partially confirmed (BPRM not)	confirmed
H2 (SO → BPQ)	partially confirmed (only SOA)	rejected	confirmed	partially confirmed (SOE confirmed, SOA reversed)
H3 (Tech. → BPQ)	confirmed	confirmed	confirmed	confirmed
H4 (interaction → BPQ)	confirmed	confirmed	confirmed	confirmed

Table 10. Test results

5 Discussion

First of all, we can basically conclude that the proposed research model explains substantial parts (almost 50%) of the variance of process quality – only B2B integration is explained to a lesser degree (R^2 up to 27%) which can be traced back to the fact that B2B integration depends on substantially more other (external) factors, such as on the B2B partners' behavior.

When focusing on the results of testing the basic hypotheses (H1 – H3), our results show that only business process documentation as well as technology (or more specifically: XML, Web Services, and registry/repository) significantly promote *all* of the dimensions associated with business process quality.

BP analysis interestingly is only related to quality control and standardization/consolidation. However, it also exhibits the highest effect on quality control compared to all other determinants, as especially the comparison of the executed processes with the desired performance level supports the usefulness of quality control and is a basic requirement for identifying redundant process variants in order to standardize and/or consolidate them.

Process reference models contribute only to STP and consolidation but not to B2B integration and quality control. This is quite curious since one of the main objectives of these models is to facilitate B2B integration by offering standardized process modules and exchange models. The data indicates that the adoption of reference models within the BPM context is still in an immature stage with firms focusing rather on in-house optimization than on extending their process configurations to partners and processes outside the own firm based on reference models (which actually is a primary goal of reference models like ebXML or RossettaNet). The immature stage is reflected by the very right-skewed distribution of answers regarding item BPRM1[39].

While the evidence for SOA's positive impact on STP and quality control is existent but has been expected, the negative impact on standardization/consolidation is counter-intuitive. One explanation seems to be, that service orientation on the IT layer alone mainly increases the complexity, due to the need to orchestrate a large number of components (i.e., services) in order to adequately support the business processes, and thus might have a negative impact on effectively governing process standardization activities. The problem of governing many modular services without

[39] "Our firm uses reference process models (e.g., RosettaNet, ebXML) in order to achieve a high degree of process standardization." (cf. Table 3 and Table 11 in the appendix)

properly supporting technology (such as registries or repositories) has also been a major issue in one of our case studies conducted in a German bank. This company started its SOA initiative without a registry/repository and, as a consequence, faced serious problems handling the increasing number of available services. Thus, in a second step, they are implementing a registry/repository in order to gain control over the services and to direct the future development and ensure that existing functionality is re-used instead of being repeatedly developed.

But, when service orientation on the IT layer comes along with service orientation on the enterprise layer (SOE) and is also supported by appropriate information technology, such as ESB, BPEL, or registries/repositories, (cf. positive interaction effects) firms can handle the additional complexity associated with service orchestration and leverage the expected benefits of SOA for business process quality. Therefore, in case of holistically following the service-oriented paradigm both on the IT level *and* the organizational level, hypothesis 2 is confirmed.

Another issue to be explained is the missing link between SOA and B2B. One reason is that B2B integration still often happens by static point-to-point integration instead of using flexible, service-related, and reference model-based (e.g., ebXML and others) concepts. Therefore, even when a firm has implemented an SOA, this currently does not play a substantial role for B2B integration because at this rather early stage of SOA adoption services are first developed for internal use. Thus, the opportunity to integrate business processes relies on the availability of services (internally and externally) and also on the appropriateness of the designed services with respect to granularity, because the implemented services do not necessarily fit the needs of the business partners and therefore would require a redesign which circumvents realizing the SOA advantages for B2B integration.

Moving the focus to service orientation on the organizational level (SOE), it is revealing that SOE is 'only' related to standardization/consolidation but not with any other process quality dimension. While the most obvious link is confirmed by the data, missing evidence for the other dimensions might be explained by STP, B2B integration, and quality control being much more dependent on IT-related issues than on a consistently service-oriented model of the firm and its activities. For example, in order to realize STP and B2B integration business processes not only have to be integrated on the process level, but also on the IT layer in order to avoid media discontinuities when executing business processes. Also, quality control requires supporting IT, and thus SOE alone is not sufficient to increase business process quality.

With respect to the concrete information technologies, XML has evolved to a heavily utilized format for exchanging data, not only in firm-internal STP but also for B2B integration. In addition, a standardized data format promotes quality control as for example the quality or completeness of the data gathered in activities of a business process can be analyzed more easily than legacy data formats.

Further, the positive relationship between Web Services and STP is interesting, since traditional enterprise application integration (EAI) technologies are commonplace within firms and Web Services are still maturing and involve additional costs (Keen et al. 2004). But, case studies, which we conducted in various banks and other service enterprises, show that a large proportion of (IT-supported) business processes in service industries are customer-related and that these customer-related processes not only become vertically integrated but also modularized due to increasing multi-channel management demands. In these areas, service-oriented technologies in general and Web Services in particular have found much acceptance.

The positive impact of Web Services on B2B integration can be explained by the inherent characteristics of Web Services, such as independence of platform and programming language, which allow firms to integrate business processes not only due to exchanging (XML) data but also with respect to application logic. Also interesting is the result that ESB correlates with B2B integration but not with STP. One explanation could be that STP had been established long before the ESB concept appeared. Therefore, legacy systems and other applications had been integrated by earlier EAI concepts before the SOA paradigm emerged. Moreover, in newly formed B2B relationships, younger technologies, such as ESB, can be used to integrate external partners as “service providers” without becoming dependent on older approaches used before (Keen et al. 2004).

While XML is dominant regarding the influence on STP, B2B integration, and consolidation, SCA and SDO have the highest impact on quality control. Clearly defined architectures and data objects can be seen as an important input for quality control, as deviations from the reference can be identified more easily. More surprising is that SCA and SDO are not linked with the other process quality dimensions of integration and consolidation. However, as SCA describes a model for composing business solutions out of service components, SCA primarily supports building single applications using SOA and not facilitating STP, B2B integration, or consolidating activities across different applications. The same argumentation also holds for SDO, which provides solutions for handling data within applications, regardless of the heterogeneity of the source, but not across different applications.

Finally, BAM is positively related to all process quality dimensions except STP. This could simply result from the fact that BAM is not widely used, yet. Summarizing, hypothesis 3 is mainly confirmed. In particular, XML, Web Services and the use of registries/repositories contribute to all dimensions of business process quality while in turn one of the main objectives of service orientation, i.e., process standardization and consolidation, is positively related with almost all technologies (except SCA/SDO).

The analysis of the interaction effects confirms hypothesis 4 and provides empirical evidence that BPM, SO, and Technology together positively affect business process quality by all of its dimensions. While the interplay between BPM and SO even alone contributes to all process quality dimensions in a significant way and thus quite impressively shows the valuable complementarities of these two concepts, the joint effects of BPM * Technology and SO * Technology only contribute to one process quality dimension each (BPM * Technology → STP vs. SO * Technology → consolidation). These results are comprehensible since we already discussed the minor role of SOA in an STP context but critical importance for identifying and consolidating redundant business activities. The analysis of the effect sizes also revealed the role of SO as moderator for BPM in B2B scenarios. While SO alone does not influence B2B integration surrounded by BPM, it increases the effectiveness of BPM for integrating business partners. This result shows that service-oriented concepts alone do not contribute to B2B integration, but that SO has an important role to implement the newly designed business processes of BPM both on the enterprise architecture layer and on the IT layer.

Limitations

Before drawing conclusions we need to discuss the limitations of our results. First, the evaluation of the measurement model has shown some minor issues. As this is the first quantitative study examining the interplay of BPM and SOA, we were forced to use self-developed measurement instruments which might not perfectly fit the concepts they should reflect, particularly in highly complex organizational environments and in the SOA domain where the literature frequently demonstrates confusion about technical terms and concepts. Nevertheless, due to a still low rate of adoption of SOA-related concepts and technologies we were not able to focus on a single business domain in order to more precisely delimit the application object and to more precisely specify our measurement instrument. Moreover, the low adoption rates regarding SOA and regarding the related technologies might limit the detection of their impact on process quality; therefore, the found evidence might be interpreted rather as lower boundary for the actual impact of SOA on business process quality.

As most survey-based studies, our research potentially suffers from a single-respondent bias. Although we did not find a substantial indication for CMV in our data, solely surveying the perspective of the IT executive or leading IT architect might be restricted to a more technical understanding and thus might not fully reflect the state and impact of non-IT related aspects such as the role and importance of SOE.

6 Contributions and Conclusion

In conclusion, the results are summarized as follows to answer our research question:

1. There is a positive interaction effect (i.e., complementarity) between BPM and the implementation of a service-oriented paradigm towards business process quality. However, the role of service orientation proves to be somehow (maybe: still) limited, while the impact of BPM and related information technologies is very clear.
2. The impact of service orientation is (comparatively) strongest towards the standardization + consolidation and B2B integration dimensions of process quality. These are the main dimensions to which SO can contribute, by identifying redundant business activities and by supporting the integration of external services from B2B partners within the firm's value chain.
3. Both business process management and supporting technologies are the most important drivers of business process quality, as they contribute to every single dimension of BP quality (i.e., STP, B2B integration, standardization + consolidation, and quality control) directly.

Our study contributes to existing research as follows:

- To the best of our knowledge, it is the first quantitative study which empirically analyzes the role of the interplay of BPM and SOA for business process quality and provides multi-faceted evidence for the importance of SOA in BPM effectiveness in case of a holistic SOA approach (enterprise architecture (SOE) *and* IT architecture (SOA)).
- To our knowledge, it is also the first study that developed and empirically evaluated a multidimensional measurement model for SOA with respect to (a) SOA-related technologies, (b) service orientation on the IT architecture layer, and (c) service orientation on the enterprise architecture layer. In this way, we could empirically analyze the relations between certain SOA-related technologies and process quality dimensions in order to highlight and discuss the importance of certain technologies in a BPM context.

- As a side result, our multidimensional measurement approach of SOE / SOA / SOA-related technologies highlights inconsistencies in IT managers' perceptions regarding the adoption of SOA. While many of them state the operation of a service-oriented IT architecture, related technologies such as, ESB and service frameworks such as Web Services, are not used firm-wide. This shows potential shortcomings of earlier studies and market research, like the Scheer survey, since the degree of actual SOA adoption (in terms of implementation) might be substantially lower than suggested by these studies.

Practitioners can use the results to identify the most important drivers for business process quality. For example, business process documentation has shown significant effects on all dimensions and is therefore an indispensable aspect of BPM - although the responding firms on average reported only about 54% of their business processes as currently documented (cf. descriptive statistics regarding this item (BPD2) in the appendix). Our results also show that practitioners who want to adopt SOA must not only focus on the IT architecture but also need to involve the enterprise architecture, in order to effectively support BPM. Further, the importance of registries/repositories and business activity monitoring should be kept in mind aside from the basic technologies, such as XML and Web Services.

Further Research

For a future study, when the technologies have reached a more mature degree of adoption, we propose to conduct a configurational study to gain further insights. This will allow for comparing the success and process performance of firms exhibiting different types of technology configurations and thus uncover the IT strategy behind and its impact on organizational performance in certain settings. Nevertheless, this will require higher degrees of adoption of the focal technologies throughout the market in order to gather sufficiently large groups of firms representing the different technology configurations. Further, future research should also investigate a more comprehensive set of BPM technologies and methods subject to the SOA paradigm becoming more and more apparent in all layers of the firm's architecture.

7 References

Allweyer, T. 2009. *Geschäftsprozessmanagement - Strategie, Entwurf, Implementierung, Controlling*, (3rd ed.). Herdecke: W3L-Verlag.

Bae, H. and Seo, Y. 2007. "BPM-based integration of supply chain process modeling, executing and monitoring", *International Journal of Production Research* (45:11), pp. 2545–2566.

Bagozzi, R.P. and Yi, Y. 1988. "On the evaluation of structural equation models", *Journal of the Academy of Marketing Science* (16:1), pp. 74-94.

Bajwa, I.S., Samad, A., Mumtaz, S., Kazmi, R., and Choudhary, A. 2009. "BPM meeting with SOA: A customized solution for small business enterprises", in: *2009 International Conference on Information Management and Engineering*. Los Alamitos, CA, USA: IEEE Computer Society, pp. 677–682.

Barringer, B.R. and Harrison, J.S. 2000. "Walking a tightrope: Creating value through interorganizational relationships", *Journal of Management* (26:3), pp. 367–403.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Beimborn, D., Joachim, N., and Münstermann, B. 2009. "Impact of service-oriented architectures (SOA) on business process standardization - proposing a research model", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Bieberstein, N., Bose, S., Fiammante, M., Jones, K., and Shah, R. 2005. *Service-oriented architecture (SOA) compass: Business value, planning, and enterprise roadmap*. Upper Saddle River, NJ: IBM Press.

Brahe, S. 2007. "BPM on top of SOA: Experiences from the financial industry", in: *Business process management,* P.D.G. Alonso and M. Rosemann (eds.). Heidelberg: Springer, pp. 96–111.

Brown, G. and Carpenter, R. 2004. "Successful application of service-oriented architecture across the enterprise and beyond", *Intel Technology Journal* (8:4), pp. 345–359.

Chin, W.W., Marcolin, B.L., and Newsted, P.R. 2003. "A partial least squares latent variable modeling approach for measuring interaction effects: Results from a monte carlo simulation study and an electronic-mail emotion/adoption study", *Information Systems Research* (14:2), pp. 189–217.

Cohen, J. 1988. *Statistical power analysis for the behavioral sciences*, (2nd ed.). Hillsdale: Lawrence Erlbaum Associates.

Davenport, T.H. and Short, J.E. 1990. "The new industrial engineering: Information technology and business process redesign", *Sloan Management Review* (31:4), pp. 11-27.

Dawes, J. 2008. "Do data characteristics change according to the number of scale points used?", *International Journal of Market Research* (50:1), pp. 61–77.

Elzinga, D.J., Horak, T., Lee, C.-Y., and Bruner, C. 1995. "Business process management: Survey and methodology", *IEEE Transactions on Engineering Management* (24:2), pp. 119–128.

Erl, T. 2007. *SOA principles of service design*. Upper Saddle River, NJ: Prentice Hall.

Fettke, P., Loos, P., and Zwicker, J. 2005. "Business process reference models: Survey and classification", in: *Business process reference models - proceedings of the Workshop on Business Process Reference Models (BPRM 2005),* E. Kindler and M. Nüttgens (eds.). pp. 1–15.

Gefen, D., Straub, D.W., and Boudreau, M.-C. 2000. "Structural equation modeling and regression: Guidelines for research practice", *Communications of the Association for Information Systems* (4:1), pp. 1–77.

Hammer, M. 1990. "Reengineering work - don't automate, obliterate", *Harvard Business Review* (68:4), pp. 104-111.

Hammer, M. and Champy, J. 1993. *Reengineering the corporation: A manifesto for business revolution*. New York, NY: Harper Collins Publishers.

Heinrich, B., Henneberger, M., Leist, S., and Zellner, G. 2009. "The process map as an instrument to standardize processes: Design and application at a financial service provider", *Information Systems and e-Business Management* (7:1), pp. 81–102.

Ho, D.T.-Y., Jin, Y., and Dwivedi, R. 2009. "Business process management: A research overview and analysis", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA.

Hung, R.Y.-Y. 2006. "Business process management as competitive advantage: A review and empirical study", *Total Quality Management* (17:1), pp. 21–40.

IDS Scheer. 2006. "Business process report 2006", Saarbrücken.

IDS Scheer. 2007. "Business process report 2007", Saarbrücken.

Janssen, M. 2008. "Exploring the service-oriented enterprise: Drawing lessons from a case study", in: *Proceedings of the 41st Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society.

Janssen, M. and Joha, A. 2008. "Emerging shared service organizations and the service-oriented enterprise: Critical management issues", *Strategic Outsourcing: An International Journal* (1:1), pp. 35–49.

Jeng, J.-J., Chang, H., and Chung, J.-Y. 2004. "A policy framework for web-service based business activity management (BAM)", *Information Systems and e-Business Management* (2:1), pp. 59–87.

Juran, J.M. 1986. "The quality trilogy: A universal approach to managing for quality", *Quality Progress* (9:8), pp. 19–24.

Keen, M., Acharya, A., Bishop, S., Hopkins, A., Milinski, S., Nott, C., Robinson, R., Adams, J., and Verschueren, P. 2004. *Patterns: Implementing an SOA using an enterprise service bus*. IBM Redbooks.

King, W.R., Liu, C.Z., Haney, M.H., and He, J. 2007. "Method effects in IS survey research: An assessment and recommendations", *Communications of the Association for Information Systems* (20:1), pp. 457–482.

Krafzig, D., Banke, K., and Slama, D. 2005. *Enterprise SOA: Service-oriented architecture best practices*. Upper Saddle River, NJ: Prentice Hall.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007. "SOA and information sharing in supply chain: “How” information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Leymann, F. and Roller, D. 2006. "Modeling business processes with BPEL4WS", *Information Systems and e-Business Management* (4:3), pp. 265–284.

Liang, H., Saraf, N., Hu, Q., and Xue, Y. 2007. "Assimilation of enterprise systems: The effect of institutional pressures and the mediating role of top management", *MIS Quarterly* (31:1), pp. 59-87.

Mathieson, K., Peacock, E., and Chin, W. 2001. "Extending the technology acceptance model: The influence of perceived user resources", *The DATA BASE for Advances in Information Systems* (32:3), pp. 86-112.

Münstermann, B., Eckhardt, A., and Weitzel, T. 2009. "Join the standard forces - examining the combined impact of process and data standards on business process performance", in: *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA.

Münstermann, B. and Weitzel, T. 2008. "What is process standardization?", in: *Proceedings of the International Conference on Information Resources Management (Conf-IRM)*. Niagara Falls, ON, Canada.

Nunnally, J.C. 1978. *Psychometric theory*, (2. ed.). New York, NY: McGraw-Hill.

Oh, L.-B., Leong, Y.-X., Teo, H.-H., and Ravichandran, T. 2007. "Service-oriented architecture and organizational integration: An empirical study of IT-enabled sustained competitive advantage", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Papazoglou, M.P. and Heuvel, W.-J. 2007. "Service oriented architectures: Approaches, technologies and research issues", *The VLDB Journal* (16:3), pp. 389–415.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. 2003. "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Psychology* (88:5), pp. 879–903.

Powell, T.C. 1995. "Total quality management as competitive advantage: A review and empirical study", *Strategic Management Journal* (16:1), pp. 15–37.

Ringle, C.M., Wende, S., and Will, A. 2007. "SmartPLS 2.0 (M3) Beta". Hamburg.

Sánchez-Rodríguez, C., Hemsworth, D., Martínez-Lorente, Á.R., and Clavel, J.G. 2006. "An empirical study on the impact of standardization of materials and purchasing procedures on purchasing and business performance", *Supply Chain Management: An International Journal* (11:1), pp. 56-64.

Smith, H.A. and McKeen, J.D. 2008. "Creating a process-centric organization at FCC: SOA from the top down", *MIS Quarterly Executive* (7:2), pp. 71–84.

Tsai, T.-M., Huang, W.-S., Chang, C.-C., Wu, F.-T., and Chou, S.-c. 2007. "eXFlow: A web services-compliant system for supporting B2B process integration", *Information Systems and e-Business Management* (5:1), pp. 47–64.

Ungan, M.C. 2006. "Standardization through process documentation", *Business Process Management Journal* (12:2), pp. 135–148.

van der Aalst, W., ter Hofstede, A.H.M., and Weske, M. 2003. "Business process management: A survey", in: *Business process management*. Berlin: Springer, pp. 1019–1030.

Viering, G., Legner, C., and Ahlemann, F. 2009. "The (lacking) business perspective on SOA - critical themes in SOA research", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 45–54.

Weitzel, T., Martin, S.V., and König, W. 2003. "Straight-through Processing auf XML-Basis im Wertpapiergeschäft", *Wirtschaftsinformatik* (45:4), pp. 409-420.

Woodley, T. and Gagnon, S. 2005. "BPM and SOA: Synergies and challenges", in: *Web information systems engineering,* A.H.H. Ngu, M. Kitsuregawa, E.J. Neuhold, J.-Y. Chung, and Q.Z. Sheng (eds.). Heidelberg: Springer, pp. 679–688.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

Zairi, M. 1997. "Business process management: A boundaryless approach to modern competitiveness", *Business Process Management Journal* (3:1), pp. 64–80.

8 Appendix

Construct	Item	Mean	St. dev.	Skewness	Curtosis	Loadings
BP reference Models	BPRM1	-1.69	1.57	1.07	0.05	0.667 – 0.842
	BPRM2	0.30	1.76	-0.33	-1.01	0.763 – 0.910
BP documentation	BPD1	-0.03	1.20	-0.05	-0.96	0.904 – 0.960
	BPD2	53.73	28.01	-0.12	-1.14	0.872 – 0.926
BP analysis	BPA1	-0.52	0.95	0.20	-0.69	0.738 – 0.916
	BPA2	-0.57	1.01	0.32	-0.69	0.859 – 0.981
SOE adoption	SOE1	-0.35	1.13	-0.00	-1.07	0.906 – 0.951
	SOE2	-0.48	1.09	0.09	-1.08	0.951 – 0.984
SOA adoption	SOA1	-1.01	1.65	0.55	-0.85	0.935 – 0.954
	SOA2	-1.08	1.58	0.40	-1.07	0.950 – 0.962
	SOA3	-0.97	1.67	0.43	-0.93	0.895 – 0.912
	SOA4	-1.51	1.34	0.68	-0.16	0.851 – 0.884
Consolidation	CON1	-0.09	1.00	-0.19	-0.70	0.831
	CON2	-0.27	1.28	-0.03	-1.24	0.843
STP	STP1	0.80	1.54	-0.53	-1.01	0.708
	STP2	0.42	1.59	-0.33	-1.05	0.762
	STP3	0.61	1.53	-0.48	-0.74	0.845
	STP4	0.68	1.29	-0.63	-0.13	0.834
Quality control	QCO1	-0.25	1.68	0.07	-1.00	0.920
	QCO2	0.34	1.47	-0.28	-0.70	0.883
B2B integration	B2B1	0.42	1.42	-0.43	-0.63	0.944
	B2B2	0.51	1.48	-0.49	-0.70	0.937
	B2B3	0.19	1.55	-0.23	-1.03	0.922

Table 11. Statistical properties of the indicators used

PAPER VI

DO SERVICE-ORIENTED IT ARCHITECTURES FACILITATE BUSINESS PROCESS OUTSOURCING? A STUDY IN THE GERMAN SERVICE INDUSTRY

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Abstract

How does a firm's IT architecture affect its potential to outsource business processes? As Information Technology (IT) has become many firms' essential operational infrastructure or "backbone", we are interested in scrutinizing to what extent the kind of IT architecture affects a firm's boundaries or the plasticity of its boundaries. Focusing on the particular concept of service-oriented architectures (SOA), we concretely ask: How does SOA affect business process outsourcing potentials? Since SOA is widely expected to modularize the IT implementation of business processes, it should increase business process outsourcing (BPO) in terms of buying in the provision of single business functionalities.

We develop and empirically evaluate a theoretical model that conceptualizes the relationship between SOA and BPO. Questionnaire data from 115 firms give first evidence that SOA facilitates BPO. By increasing IT modularity, SOA supports BPO by increasing sourcing flexibility and, in particular, operational benefits, while at the same time lowering financial risks and strategic risks, such as lock-in. Overall, however, firms see SOA-based BPO mainly in an operational context with low hidden costs and little strategic benefits.

1 Introduction

With the spread of the internet and the opportunities information technology (IT) provides, most firms are engaged in some forms of e-business. Inter-organizational systems (IOS) have given companies the chance to rethink their internal value creation and business operations in order to outsource tasks which others can provide more (cost-) efficiently, with higher quality, and with higher competence. Consequently, business process outsourcing (BPO) of selected activities provides an attractive course of action for a firm to reshape its borders in terms of make-or-buy. While there is much research on IOS and their role in inter-firm value creation (Umar 2005), little attention has been given to the question of how a firm's *internal* IT should be designed and configured to support reshaping the firm's borders by outsourcing certain business tasks.

In this context, the paradigm of service-oriented architectures (SOA) enables new forms of cross-firm exchanges when – based on an SOA – business processes can be exchanged and combined like modular services within and across firm borders. A firm that has its business processes technically implemented based on SOA will (ideally) run services that provide those business functions which form the business processes. For example, "opening a bank account" is a business function which is an inherent part of various business processes in a bank (e.g., offering a checking account, granting a loan, etc.). If this functionality is implemented as a service and offered by one single IT system within the SOA, it can offer this service to all applications that support business processes requiring the opening of an account. Figure 1 helps clarify this argument.

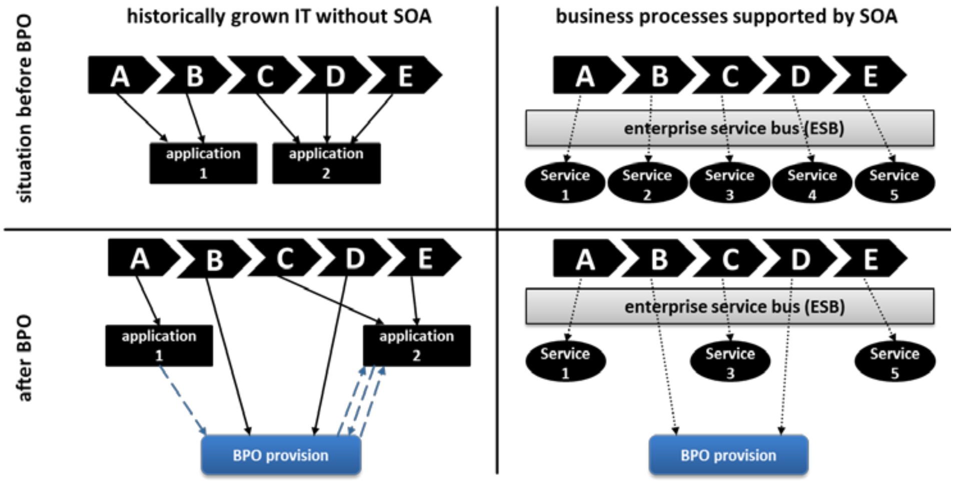

Figure 1. Comparison of BPO based on historically grown IT vs. SOA

Firms with historically grown IT architectures and without using SOA (cf. top left corner of Figure 1) are often running multiple single applications, which support several business functions of a particular business process. If such a firm decides to outsource parts of a business process (e.g., business functions B and D in Figure 1), additional interfaces between the BPO provider and the still running applications supporting the business functions remaining in-house (A, C, and E in the lower left corner of Figure 1), have to be implemented and maintained. In this example, four additional interfaces for exchanging the outcomes of the business functions (between A and B, B and C, C and D, as well as D and E) have to be established between the remaining in-house applications 1 and 2 as well as the systems of the BPO provider.

Instead, if the business functionality is encapsulated in services (cf. right side of Figure 1), a firm might more easily outsource the provision of a particular – more or less granular – business function (or: a service) because it has already decided which functions comprise which services and because SOA provides the flexibility to change, add, or replace services (in terms of IT-embedded process logic). Moreover, all services already offer an interface to the enterprise service bus (ESB), which makes no changes to existing or additional interfaces necessary. Thus, while a firm continues to perform some of the business functions in-house, the consequent use of services supports outsourcing of other services, all interacting with each other along the business process via the ESB (reflected by the dotted lines). Examples of typically outsourced business functions, which are often not in the firm's core anymore, can include certain administrative steps such as travel expense administration, accounts payable and receivable, payments processing, account administration, etc. From the client's perspective, the advantage of BPO based on SOA vs. historically grown IT architectures is basically independent of the architecture used by the BPO provider. The provider is not required to also have an SOA in place, as only the defined output is required and the client's ESB allows the output to be integrated into the existing business process[40].

SOA can thus "lead to commoditization and outsourcing on a massive scale" (Davenport 2005, p. 100). Considering that such a 'division of services' rests on both, IT architecture flexibility and

[40] In this work, we focus purely on the client firm's IT architecture. "Service" in this SOA-related sense must not be confused with the services delivered by an outsourcing provider, although there is of course a close connection between both concepts in our work: a (SOA) service, whose business functionality is outsourced, will be replaced by a service provided by the outsourcing provider.

modularity on the one side and externalization of business processes (Business Process Outsourcing, BPO) on the other, we take the discussion into a concrete and matured IS research domain and scrutinize whether firm borders are potentially affected by the underlying IT architecture. Thus, our research question is: *Does SOA facilitate BPO?*

From a BPO perspective, the analysis reveals the extent to which IT architecture is a BPO driver and/or readiness factor. BPO is associated with certain advantages, such as cost advantages and quality improvement, as well as certain risks (e.g., friction costs or loss of performance or quality). We thus propose a research model that highlights the role of a firm's internal IT architecture and its effects on BPO benefits and risks. While this area has largely been neglected in prior research, we strive in particular to resolve the relationship between BPO potentials and the degree to which a firm has designed and implemented its IT infrastructure along the paradigms of SOA. We anticipate that the higher degree of IT modularity provided by an SOA increases the potential BPO benefits and reduces the involved BPO risks and thus propose that SOA will facilitate or even enable (additional) BPO activities in the future.

Indeed, empirical data from 115 firms shows that SOA facilitates BPO and contributes to an "industrialization" of IT-enabled business processes. At the same time, BPO benefit realization requires an alignment between the implemented SOA-based services and the process level modularity so that services resemble business functions. This research improves our understanding of how SOA affects the design and outsourcing of business processes; and thus contributes to an examination of the business value of SOA. Subsequently, practitioners can use our findings to structurally evaluate whether SOA might be an adequate architectural foundation for BPO initiatives.

The remainder of this article is structured as follows: after introducing the concepts of modularity, SOA, and BPO, we develop our research model. The theoretical argument is that the extent of a firm's SOA adoption is related with potential BPO benefits and risks. Empirical construct operationalization, data collection, and analysis methods are described in section 4. In section 5, we present the results of the analyses before discussing findings and limitations in section 6.

2 Basics

2.1 Modularity

The question whether SOA leads to more outsourcing of business processes and thus to changes of the firm's borders is mainly about the role and effect of modularity. Modularity has been investigated in manifold fields, such as Information Systems (role of IT modularity), Production Research (role of product modularity), or Organization Science (role of organizational modularity). All of these fields usually draw on Modular Systems Theory.

Modular Systems Theory essentially argues that a system consists of distinct sub-systems which interact with each other and are to a certain degree both independent and interdependent (Schilling 2000; Simon 1962). Modularity manifests in independence rather than interdependence. "The crux of modular systems theory is that greater modularity facilitates rapid changes in individual subsystems by lowering the need for coordinated changes in others" (Tiwana and Konsynski 2010, p. 290). In turn, a decrease of coordination needs and efforts leads to higher flexibility and real options (Tiwana 2008) for adapting the system to an emerging need.

The oldest strand of modularity research in the business field emerged in the product design domain. Modularity of physical products has important implications for R&D effectiveness (Takeishi 2002), production efficiency (Baldwin and Clark 2000), sourcing strategies (Schilling 2000), and the organizational structure of the manufacturer, because the modularity of the manufacturer's *organization* should be aligned with the modularity of the products manufactured (Hoetker 2006; Langlois 2002). Modularity of both the product and the organization enables the firm to outsource parts of the product development and has led to a blurring of firms' boundaries and to strong increases in interorganizational relationships and alliances (Anand and Daft 2007; Duncan 1979). The organizational designs have shifted away from strictly functional or matrix designs, where a firm has clear boundaries between itself and its suppliers and customers, to modular organizational designs where parts of business processes or of products are outsourced to others (Anand and Daft 2007). For example, the automotive industry has modularized both their products and their organizations, turning them "into vehicle assemblers and outsourcing much of the manufacturing and assembly of the parts of the vehicle" (Ro et al. 2007, p. 180).

The existing literature has mainly investigated the impact of modularizing products on manufacturing outsourcing rather than of modularizing (immaterial) business processes. For example, Momme et al. argue that higher product modularity allows a distinction to be made "between strategic and non-strategic components and thereby preserve the core competencies associated with the product and process technology" (2000, p. 135). Also, Ernst and Kamrad argue that "the higher the level of modularization, the easier it is to outsource manufacturing or its constituent components" (2000, p. 496). By moving the focus from products to business processes we argue that product modularization and business process modularization are comparable concepts. A business process consists of logically related tasks (Davenport 2005), which match with the components of a product. Also, a business process can be broken down into sub-processes (Basu and Blanning 2003). Thus, modularizing products into modules is comparable to modularizing processes into sub-processes. Moreover, the outcomes of a business process, even if immaterial (such as services), can be handled in a similar way to physically assembled products. In addition, if a larger variety of different services is offered to customers, this often also leads to an implementation of a variety of business processes, as the outcome of a business process is directly related to the process itself.

This variety of processes is typically supported by information systems (IS) in today's organizations. These can be secondary processes such as payroll processing or HR processes, which are very IT-reliant, but also primary processes along the value chain such as procurement, warehousing, or order-tracking (cf. also Figure 4 in section 4.1). One way of modularizing these IT-reliant business processes is by using SOA. The single services of an SOA encapsulate parts of business processes (i.e., business functions) in order to minimize interdependencies between different modules (Mithas and Whitaker 2007). According to previous research (Mikkola 2003; Sanchez and Mahoney 1996), modules that are decoupled, such as business functions that are modularized through SOA and standardized interfaces, can be easier outsourced.

2.2 Service-Oriented Architectures (SOA)

The complexity of a firm's IT infrastructure – consisting of a huge variety of different systems and applications which are somehow integrated by a historically grown network of links and interfaces – often increases dramatically over time, because the IT fulfills individual change requests of different business departments. Such local demands not only lead to increasing complexity but also to redundancy of data and functionalities, which are to a certain degree implemented repeatedly for different business processes in different IT systems. Several years ago, SOA emerged as a comprehensive paradigm, supporting the reconfiguring of a firm's overall IT infrastructure by designing it with an overarching perspective instead of focusing on developing single systems, as compared to object- or component-orientation (Siedersleben 2007). Both practitioners and researchers offer a multitude of definitions and conceptualizations of SOA, which vary from a purely technical focus to a holistic focus covering IT and business. According to Krafzig et al. (2005, p. 57) "a Service-Oriented Architecture (SOA) is a software architecture that is based on the key concepts of an application frontend, service, service repository, and service bus". In contrast to this IT-centric perspective, Bieberstein et al. (2005a, p. 5) define SOA with respect to both IT and business as a "framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities". Additionally applying the service paradigm at the business level results in the so-called Service-Oriented Enterprise (SOE): "The SOE is an enterprise that is modularized in business domains" (Janssen and Joha 2008, p. 35).

On the IT layer, service orientation is associated with common design principles, for example, reusable logic is encapsulated into implemented services, services share a formal contract, and are loosely coupled, composable, autonomous and stateless (Bieberstein et al. 2005a; Erl 2004). For connecting the different services, an enterprise service bus (ESB) is used in an SOA. *Business services* represent business functions implemented in IT; they are based on standardized interfaces and are independent from programming platforms. Using such services offers the opportunity to flexibly orchestrate and reuse services in different business processes and even supports offering services to third parties, i.e., acting as a service provider (Zhao et al. 2007). Thus, SOA represents a promising opportunity to match the concept of modularizing business processes adequately with a modularization concept on the IT layer. As business processes are often highly IT-reliant, the highlighted concept of modularizing business processes into sub-processes or business functions, which can be implemented as business services on the IT layer, demands an IT concept which is structured similarly. SOA is inherently geared towards modularization, which is also apparent in the definition given by Bieberstein et al. (2005a) and presented above. SOA is explicitly related to integrating and combining business processes, which consist of standardized services. Moreover, the inclusion of the business perspective on servitization (i.e., SOE) facilitates shifting a firm's borders as not only is the IT modularized but the organization is as well. Thus, a service-oriented IT provides the foundation for the long-demanded flexibilization of firms' borders where dynamic configuration of business processes from business functions (Oh et al. 2007) takes place regardless of whether they are located outside or inside an organization (Krafzig et al. 2005).

While most of the extant research dealing with SOA has explored its technical and architectural challenges, the organizational and economic effects of SOA have only recently come into the focus of researchers, for example, through research into conceptualizing models explaining the organizational adoption of SOA (Beimborn et al. 2008), by analyzing potential business benefits of SOA by case studies (e.g. Baskerville et al. 2005; Yoon and Carter 2007) or empirically evaluating the business value of SOA (Joachim et al. 2011b), or specific benefits of SOA, such as organizational integration (Oh et al. 2007), business process quality (Beimborn and Joachim 2011) or information sharing in supply chains (Kumar et al. 2007). While Benazeer et al. (2008) argue that, based on the existing literature, adopting SOA can enhance IS outsourcing, the article on hand, to the best of our knowledge, is the first to develop and empirically examine a research model describing the impact of SOA on the potential of business process outsourcing and thus on reshaping the borders of the firm.

2.3 Business Process Outsourcing (BPO)

BPO represents the delegation of a particular business activity or an overall business process, including the related supporting services, to an external provider (Gewald and Dibbern 2009), and often also covers the transfer of the necessary resources, such as IT systems and applications supporting the outsourced business activity. However, it is – in contrast to IT outsourcing – not about serving the IT functions or running the software applications per se, but it is about delivering a business process result. Often, BPO is more closely defined as the outsourcing of IT-intensive processes, since IT enables the inter-organizational integration of business processes and thus ensures straight-through processing across firm boundaries (Dayasindhu 2004; Pfannenstein and Ray 2004). The provider takes over the complete business task and is basically free to choose how to implement and to execute it, while the outsourcing firm only receives the process outcome (Braun 2004). While BPO of many information-intensive processes (e.g., HR administration, procurement, payments processing, or accounts payable) has shown substantial benefits from both a cost and a strategic perspective, other areas still show rather low rates of adoption (cf. e.g., TPI outsourcing index at www.tpi.net).

Most research on BPO draws on the IT outsourcing research strand. Usually, research follows the established (IT) outsourcing models and empirically identifies determinants and inhibitors of BPO adoption (Gewald and Dibbern 2009; Gewald et al. 2006), determines the outcomes of BPO (Willcocks et al. 2004), or investigates the role of BPO success factors (Wüllenweber et al. 2008), such as effective control and governance structures (Kim and Kim 2008; Mani et al. 2006), effective sourcing mechanisms (Tanriverdi et al. 2007), and client firm-internal BPO readiness (Martin et al. 2008).

While, previous research has shown that increased product modularity not only eases outsourcing but also helps to distinguish between strategic and non-strategic components (Ernst and Kamrad 2000; Momme et al. 2000), only a few articles have focused on the role of IT for successful BPO. This is particularly interesting as business processes become increasingly IT-intensive and Davenport (2005) emphasizes that standard interfaces between information systems allow easier outsourcing of business activities. In addition, Abramovsky and Griffith (2006) conclude – based on their empirical study – that organizations which use more IT outsource more services. Therefore, the influence of IT modularization on BPO shows to be a neglected perspective.

3 Model Development

Our paper tackles the question whether, and how, the degree to which a firm has adopted the SOA paradigm to its IT infrastructure affects the benefits and risks associated with outsourcing business activities, or in short: will SOA facilitate and thus lead to more BPO? In the following, we develop a research model that links SOA to the BPO decision determinants.

3.1 BPO and its Determinants

A BPO decision is mainly driven by the benefits, costs, and risks involved in changing the sourcing mode of a particular business activity (Gewald and Dibbern 2009). *Anticipated benefits* will increase BPO while *anticipated risks* and related costs will decrease it. There are further – complementary – determinants of outsourcing (such as institutional pressures (Ang and Cummings 1997), imitation/bandwagon effects (Loh and Venkatraman 1992b), or fundamental in-house governance problems and weak management (Earl 1996)), but for investigating the role of SOA for BPO it is sufficient to restrict the model to benefits and risks, since those are the ones which are affected by SOA and thus help increase understanding of the relationship between SOA and BPO.

The identification of benefits as outsourcing decision determinants is one of the oldest research questions in the outsourcing field. Loh and Venkatraman (1992a) argue in one of the very first published models of outsourcing determinants, that the bad cost structure and bad performance of a firm will motivate its outsourcing activities. Over the subsequent two decades, cost advantages, in particular, have consistently shown to be the predominant outsourcing decision determinant (Dibbern et al. 2004; Lacity et al. 2009). Cost advantages can result from economies of scale (i.e., bundled processing volumes lead to lower marginal processing costs) (Kakabadse and Kakabadse 2002), economies of skill (i.e., technical or management competencies and learning effects allow the vendor to achieve superior cost structures) (Lammers 2004), or economies of scope (i.e., vendors can utilize their resources to produce different outputs for different clients). On the downside, outsourcing causes transaction costs (for negotiation, contracting, transition, provider monitoring, and relationship management (Cheon et al. 1995)) which can be substantial and can easily lead to situations where outsourcing is not economically beneficial (Ang and Straub 1998).

Beside the cost effect, organizations outsource processes in order to receive a higher level of quality (Gewald and Dibbern 2009). Vendors have specialized on particular business activities and cannot just deliver them at lower costs but often also at higher quality. For example, higher volumes justify a higher degree of automation which might not only cut processing costs but also reduce error rates. Consequently, outsourcing grants access to specialized and superior resources (technology, process skills, management knowledge, etc.) (Apte et al. 1997; Huber 1993).

From a strategic perspective, a firm can focus more effectively on its core competencies by outsourcing all non-core activities (Grover et al. 1996). Thus, the management can focus on sustaining and improving the firm´s core competencies (Quinn and Hilmer 1994; Smith et al. 1998), following the very fundamental economic principle of specialization and division of labor. Consequently, the firm is more flexible from a strategic perspective, enabling it to react to changing market demands (Slaughter and Ang 1996; Young-Ybarra and Wiersema 1999).

Dimension	Definition	Description
Cost advantages	Reduction in overall costs (production costs and transaction costs, including costs for migration, negotiation etc.)	Cost advantages result from economies of skill, scale, and scope. The vendor proposes producing the same service at a lower price. Nevertheless, cost advantages have to incorporate additional costs that are caused by outsourcing (for negotiation, contracting, migration, provider monitoring, and relationship management).
Quality improvement	Improving quality of service by tasking a provider that has superior capabilities	Outsourcing tasks to a vendor, specialized in performing these particular tasks, will lead to quality improvements for the outsourcer, which does not possess the superior capabilities necessary for performing these tasks. Moreover, outsourcing can trigger the redesign of existing processes and thus further improve the quality.
Focus on core competencies and strategic flexibility	Focus own management on the firm's core competencies in order to gain productivity and to sustain the firm's competitiveness	If the firm's management is unburdened by outsourcing tasks that are not within the firm's set of core competencies, the firm becomes more agile in the market and the management can focus on maintaining and improving existing core competencies as well as developing new ones. The development of sustainable core competencies is essential for a firm's survival and competitive advantage in the market; therefore outsourcing from a strategic perspective helps the management to stay focused and supports its long-term survivability.

Table 1. Perceived benefits of BPO

BPO is also associated with various risks. Scholars have identified different dimensions of risks and risk drivers with regard to outsourcing (Aubert et al. 1999; Bahli and Rivard 2004; Earl 1996). Based on the perceived risk framework of Cunningham (1967), Gewald et al. (2006) examine how different types of perceived risks affect the intention to outsource business processes. They define perceived BPO risks as the potential loss in the pursuit of a desired outcome of BPO and they distinguished between performance, financial, strategic, and psychosocial risks. Their empirical analysis finds the first three dimensions to be highly relevant for determining the BPO intention. We draw on their findings and propose financial risk, performance risk, and strategic risk as (negatively) influencing the intention to outsource business processes. The dimensions are described in detail in Table 2.

Dimension	Definition	Description
Financial risk	The risk that actual costs may exceed planned/budgeted costs of the outsourcing engagement	Costs may exceed the budget due to various issues (Earl 1996). Contracting and transition of services can be more expensive than anticipated, incomplete contracts might require renegotiations during the ongoing relationship, or internal management of monitoring the vendor and maintaining the relationship may lead to more effort than expected.
Performance risk	The risk that the service provided by the outsourcing vendor will not be delivered as expected by the client.	Performance risk can be caused by overextended expectations on the client side, incomplete contracts that insufficiently document the duties and service levels the vendor has to fulfill, or simply by lacking capabilities and resources on the client side. Adverse selection of incompetent vendors and moral hazard in the ongoing relationship are typical reasons for performance risk.
Strategic risk	The risk that the client firm will lose its ability to react flexibly and unconstrained to changing market conditions.	Strategic risk is often rooted in the client's loss of competencies because everything is outsourced (Earl 1996; Quinn and Hilmer 1994). Another important and related problem is the lock-in to a particular vendor's services, i.e., limited or no possibilities to backsource the service or to change the providers. These can be caused by prohibitively high switching costs, caused, for example, by the technological infrastructure or by a too low number of valid alternatives (no superior provider in the market). Finally, strategic risks are driven by the fact that contracts are inherently incomplete and that the outsourcing firm cannot prepare for every eventuality which might arise during the ongoing relationship.

Table 2. Perceived risks of BPO (based on Gewald and Dibbern 2009; Gewald et al. 2006)

An important issue when deciding upon outsourcing is the flexibility of the outsourcing engagement. If outsourcing is complex and difficult, there might be several technical, organizational, and contractual obstacles which do not allow for subsequent adaptations of the arrangement, e.g., changing processing volumes or new requirements. Tan and Sia (2006) define sourcing flexibility as the flexibility to change, extend, or reduce the BPO arrangement and to change service providers. It should not be confused with strategic business flexibility, which represents a desired outcome of outsourcing (cf. above). Tan and Sia conceptualize sourcing flexibility as consisting of four dimensions: *modifiability* and *robustness* of the outsourcing relationship, extensibility about *new capabilities*, as well as *ease of exit*. These are described in the following table.

Dimension	Definition	Description
Modifiability	Alteration of service attributes	The ability of an outsourcing relationship to allow alternation of attributes of its existing services in addressing changing business requirements, e.g., new configuration setup, alternation of processing workflow or business rules, new reporting requirements, and reference data updates.
New capability	Addition of innovative capability	The ability of an outsourcing relationship to allow the addition of entirely new services to address radical changes or shifts in business paradigms, e.g., new government regulations, technological revamps, functional breakthroughs, and process innovations.
Robustness	Variability of service capacity	The ability of an outsourcing relationship to allow operational changes exceeding projected capacity on existing service delivery, e.g., service volume fluctuation, variations in standard user requests, urgent or special case processing, and exception handling
Ease of exit	Switch to another vendor or insourcing	The ability of an outsourcing relationship to allow transfer of services to other vendors, or to be brought in-house, e.g., premature termination, vendor instability, or pricing disagreement or dispute.

Table 3. Conceptualization of perceived sourcing flexibility (Tan and Sia 2006, p. 186)

The more flexible an outsourcing arrangement is perceived to be in terms of these four dimensions, the lower the perceived outsourcing risks will be and the more likely that the benefits can be realized[41].

Hypothesis 1(a, b): The higher the perceived sourcing flexibility, (a) the higher the perceived BPO benefits, and (b) the lower the perceived BPO risks.

3.2 How SOA Affects BPO Determinants

This paper investigates how SOA influences BPO. In this section, we theorize the relationship between SOA and the BPO determinants, previously conceptualized as BPO benefits, BPO risks, and sourcing flexibility.

SOA facilitates the achievement of economies of scale, scope, and skill: by implementing an SOA, a business process is separated into single business activities which are implemented as services. Due to their modularity, these services can be executed quite independently, supporting the economic principle of labor division which in turn represents the base for achieving cost advantages from production economies. Granular division of work creates potentials for higher processing volumes by merging tasks from different business processes (and multiple client firms) (Goolsby 2008), leading to economies of scale. Further, services possess standardized interfaces and thus can be recombined differently in different contexts (Lim and Wen 2003). Thus, economies of scope can be achieved, as well.

SOA can reduce undesired software and system redundancy and thereby lowers maintenance cost (Yoon and Carter 2007). These cost savings may be even stronger if delegating the service operations to a service provider. Similarly, reuse will reduce development cost and reuse is more likely if multiple clients demand it (Lim and Wen 2003). Thus, the necessity to (re-)develop a service might decrease both on the client side and on the vendor side.

Economies of skill and quality improvements can be achieved more easily because modularity allows for modular sourcing (Benazeer et al. 2008; Ernst and Kamrad 2000) and thus economic specialization. Single business activities can be outsourced to those firms that are core competent in providing them (vom Brocke and Lindner 2004). Similarly, technological independence, modularity, and autonomy of services allow the provider firm to offer its specialized resources with lower efforts (Goolsby 2008).

From a transaction cost perspective, SOA allows for easier transition of services and change of vendors, since services (if they exhibit loose coupling and standardized interfaces) can be more easily extracted from and integrated into IT systems (Benazeer et al. 2008; Krafzig et al. 2005). Thus, the transition cost, which are a major part of the transaction costs, are lower. Moreover, SOA enables easier and more detailed activity-based performance monitoring (Müller et al. 2008;

[41] There is not much literature-based evidence about the relationship between sourcing flexibility and sourcing decisions or their determinants, yet (Tan and Sia 2006). Therefore, we draw on the common view that flexibility basically is beneficial (Avison et al. 1995; Lacity and Willcocks 2001; McFarlan and Nolan 1995); higher flexibility means a higher number of design options to choose from or to switch between – therefore, the creation of a more advantageous setting is facilitated. However, we are aware that there might be counter-arguments as well.

vom Brocke and Sonnenberg 2008). This allows the client to gain easier, direct and real-time access to performance data generated by the service provider, and thus reduces monitoring costs.

From a strategic perspective, vom Brocke and Lindner (2004) argue that SOA facilitates a firm's strategy to refocus on core competencies without outsourcing whole business processes but only selected tasks. Thus, the firm can more dedicatedly define its core competencies on the level of granular activities. A side effect would be that those core activities that are identified can also be offered to other firms (i.e., the outsourcing firm itself acts as a service provider for its core activities while outsourcing the remainder) (Oh et al. 2007).

Hypothesis 2: If a firm's IT infrastructure follows the SOA paradigm, it will perceive higher BPO benefits regarding those business processes relying on SOA.

SOA leads to modularization of business processes and a subsequent standardization of activities, since the objective is to reuse services for different processes. Therefore, each service in an SOA consists – despite other elements – of a service contract, which "provides an informal specification of the purpose, functionality, constraints, and usage of the service" (Krafzig et al. 2005, p. 59). Thus, service contracts help to provide clear and concise definitions regarding the functionality and performance of the services. Moreover, agreeing on business process standards increases performance (Davenport 2005; Münstermann et al. 2009) and transparency. This reduces the risk of misunderstandings about the service to be delivered between the parties which in turn reduces performance risk and thus facilitates outsourcing (Davenport 2005). Moreover, as argued above, SOA enables more precise and direct performance monitoring (Müller et al. 2008; vom Brocke and Sonnenberg 2008) which not only reduces monitoring costs but also lowers performance risk. Furthermore, the joint use of both process standards and IT standards regarding the communication protocols and service descriptions reduces the threat of lock-in to a particular vendor's service portfolio, which reduces strategic outsourcing risks. Service modularity and using standardized technologies also makes migration costs more controllable because the functionalities can be more easily unhinged from the outsourcer's infrastructure and integrated into the vendor's infrastructure (reducing financial risk) (Ren and Lyytinen 2008). Moreover, modular and standardized services lead to a higher number of comparable service offerings from different potential partners (vom Brocke and Sonnenberg 2008), which also reduces strategic risks (Ren and Lyytinen 2008). Finally, SOA facilitates multi-sourcing, i.e., to outsource different business activities to different service providers. This allows for a more effective balance between the three different risk dimensions[42].

Hypothesis 3: If a firm's IT infrastructure follows the SOA paradigm, it will perceive lower BPO risks regarding those business processes relying on SOA.

One of the most fundamental reasons for implementing an SOA is to increase the flexibility and adaptability of an organization's IT infrastructure (Benazeer et al. 2008). Correspondingly, Schulte et al. (2008) and Heutschi (2007) show empirically that SOA enables firms to more flexibly change business processes. In the following, we discuss whether SOA contributes to sourcing flexibility as specified by Tan and Sia (2006) (cf. Table 3). When adopting SOA, business processes are split into modular activities which are connected by interfaces and interact via standard-

[42] Multi-sourcing can nevertheless also have *negative* consequences by increasing the performance risk since the orchestration involves multiple parties with shared responsibilities. Thus, the potentials for technical coordination problems and also for moral hazard may also increase.

ized communication and messaging protocols (Lim and Wen 2003; Papazoglou and Heuvel 2007). This feature is directly related with a higher degree of *modifiability*, in contrast to traditional software applications which cover either single business functions without service-oriented interfaces or whole business processes (Papazoglou and Heuvel 2007). Loose coupling and an adequate, i.e., business activity-oriented, level of service granularity allow for easy adaptation of business processes since changes often only need to be implemented very locally in single services without affecting the overall implementation of the business process (Krafzig et al. 2005).

The same argument holds for the sourcing flexibility dimension of *new capability*. Adding new capabilities requires the integration of new services and interfaces but, if the SOA is well designed, it does not cause changes in the overall system (Ren and Lyytinen 2008). Moreover, the reusability of functionalities allows for quicker creation of new capabilities by orchestrating existing services with those that actually need to be newly developed (Bieberstein et al. 2005b). Obviously, it is again important that the SOA is well-designed and that standard protocols and service descriptions are used.

Regarding *robustness*, SOA exhibits important properties, as well. First, the ESB itself increases robustness as services can be registered in multiples and the ESB can provide load balancing based on these intentional redundancies. Thus, if processing volume increases, redundant services can be additionally utilized. Second, the use of multiple ESBs, controlled by a master-ESB, is possible and increases the robustness in terms of performance, reliability, and avoidance of overload (Siedersleben 2007). Third, the ESB can also be used to continually analyze the contents of the service requests and thus monitor and decide whether exception handling is necessary. Fourth, if the variations were foreseeable, another solution supported by SOA would be the use of other services which extend or replace the functionality of the default services to serve these particular demands. Thus, different versions of existing services can be used at the same time in order to cope with special needs while at the same time keeping redundancy of implementations as low as necessary. The adaptation of functionality in SOA is easier than adapting functionality within an entire IT system, as business functions are already separated into single services.

A well designed SOA consists of loosely coupled services, which can be altered more easily than point-to-point connections (Papazoglou and Heuvel 2007). In addition, Web Services, as one important potential implementation technology for realizing an SOA, are platform independent and rely on standardized interfaces. Therefore in a BPO context, a service requestor can switch more easily from one service provider to another; thus, SOA facilitates the exchange of vendors (*ease of exit*) (Krafzig et al. 2005).

Hypothesis 4: If a firm's IT infrastructure follows the SOA paradigm, the perceived sourcing flexibility will be higher.

Since SOA increases sourcing flexibility and sourcing flexibility in turn drives BPO benefits and hampers BPO risks, we can combine these arguments and conclude that sourcing flexibility is an important mediator for understanding the relationship between SOA and the perceived BPO benefits and risks – SOA not only increases sourcing flexibility per se, but also contributes to BPO benefits and reduces BPO risks <u>by</u> increasing sourcing flexibility.

Hypothesis 5(a, b): Perceived sourcing flexibility will mediate the relationship between SOA and both (a) perceived BPO benefits and (b) perceived BPO risks.

The following figure visualizes the research model while Table 4 summarizes our theoretical arguments between SOA and the BPO decision determinants. Since previous research has already provided evidence that and how those decision determinants drive an organization's BPO intention, we have excluded them from our analysis (Gewald and Dibbern 2009).

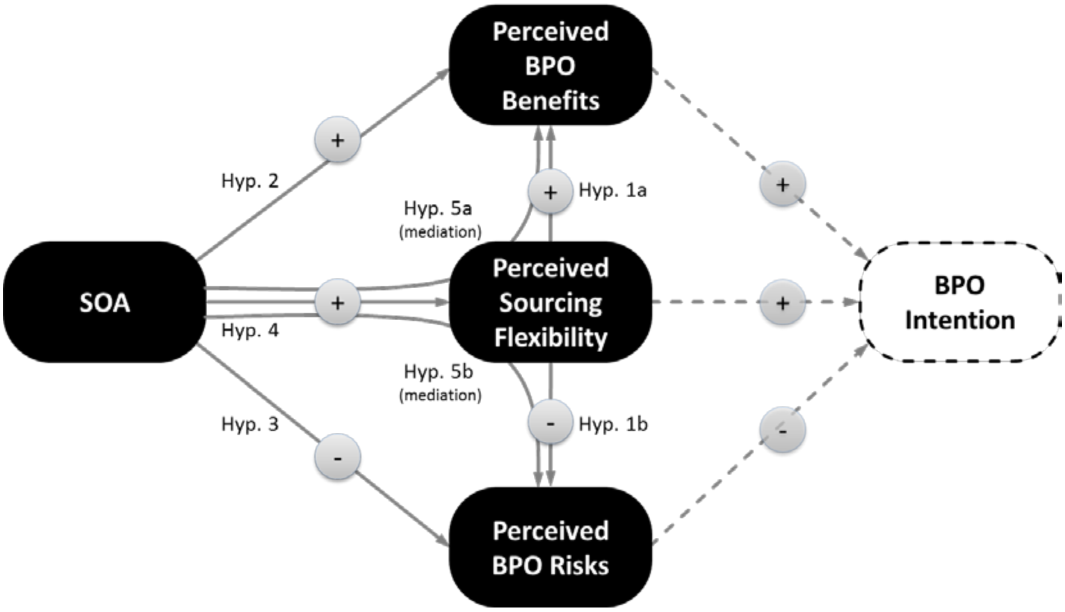

Figure 2. Research model

BPO Determinant	Effect of SOA
BPO Benefits	**Hyp. 2: SOA increases BPO benefits.**
- Cost advantage	(a) Modularity facilitates achievement of economies of scale, skill, and scope. (b) Reduction of redundancies lowers development and maintenance costs which are even stronger if bundled across different firms. (c) Modularity allows for modular sourcing of business activities to the most cost-efficient vendors for a certain task. (d) Modularity and use of standards facilitate transition of services and thus reduce transition costs. (e) SOA enables more detailed performance monitoring and thus reduces monitoring costs.
- Quality improvement	Modularity allows for modular sourcing of business activities to the most highly competent vendors for a certain task.
- Core competence focus and strategic flexibility	SOA allows for more selective outsourcing and thus for more precise outsourcing of non-strategic tasks.
BPO Risks	**Hyp. 3: SOA decreases BPO risks.**
- Financial risk	(a) Modularity and use of standards make migration costs more controllable. (b) Facilitation of multi-sourcing.
- Performance risk	(a) Service contracts explicate clear and precise service outcomes. (b) Services are increasingly based on business process standards, avoiding misunderstandings. (c) SOA enables detailed activity-based performance monitoring. (d) Facilitation of multi-sourcing.
- Strategic risk	(a) Joint use of process standards and IT standards reduces lock-in risks since backsourcing is easier. (b) Modular and standardized services lead to higher number of alternative service offerings from alternative vendors. (c) Facilitation of more granular multi-sourcing.
Sourcing Flexibility	**Hyp. 4: SOA increases sourcing flexibility.**
- Robustness	(a) The ESB allows registering multiple services for load balancing to react to increased volume. (b) Using multiple ESBs additionally increases performance, reliability, and avoidance of overload. (c) Monitoring service requests helps to analyze the necessity of exception handling. (d) Different versions of existing services can be used simultaneously to react to foreseeable changes in demand.
- Modifiability	Service modularity and business activity-based determination of service granularity facilitates changes which are often limited to single services instead of affecting the entire system.
- New capability	(a) Modularity facilitates integration of new services. (b) Reusability of functionality allows for more rapid creation of new capabilities.
- Ease of exit	SOA based on industry standards facilitates vendor replacement.

Table 4. Summary of the theoretical argumentation

4 Methodology

This section introduces our approach to data gathering and analysis, and gives a descriptive overview of our sample.

4.1 Empirical Study

In order to evaluate our research model, we surveyed firms from the German service industry (i.e., US SIC codes 4,000 to 8,999), such as financial services, IT and communications, as well as logistics and trade. Our reason for investigating the service industry was the relative importance of IT, while in other industries (e.g., manufacturing) physical assets can be a (comparatively) more important production factor and, thus, would be an important contingency to control for. We sampled 1,620 firms from the German service industry and phoned them to obtain the name and contact information of the leading IT architect, which we did successfully in 1,023 cases. To these, we distributed a paper-based questionnaire and sent reminders by phone and mail. Ultimately, we received 158 completed questionnaires (i.e., response rate of 15.4%). For the subsequent calculations we used only those questionnaires which show no missing values regarding the items used for the calculations. The descriptive overview presented in Figure 3 shows that our sample, while not a perfect reflection, does match quite well the population with respect to industry categorization and firm size (the sample slightly deviates towards larger firms).

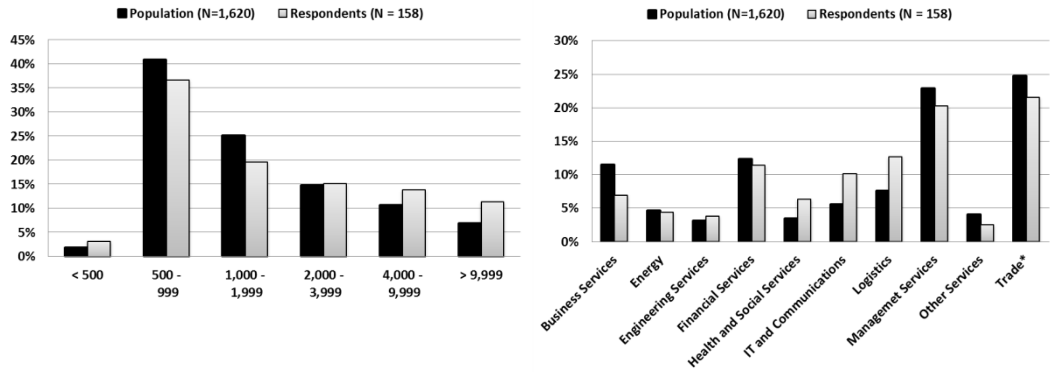

Figure 3. Left: distribution of firm size (number of employees); right: distribution of sectors within the service industry (*: some trade firms also manufacture the traded goods)

Figure 4 shows that the extent to which business processes rely on IT is indeed high (49 to 95%). By contrast, only a minority of those processes are already outsourced (2 to 10%).

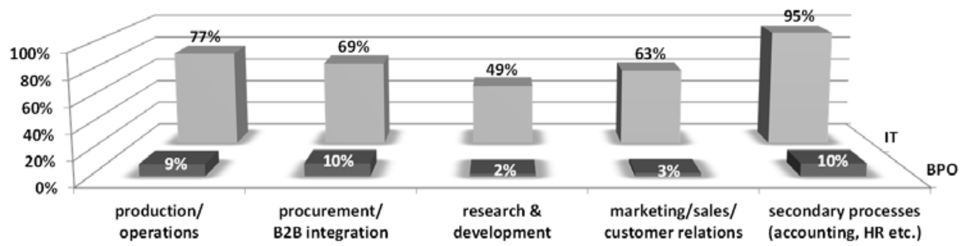

Figure 4. Comparison of the degree of BPO and IT intensity with respect to different business processes (N = 148 - 157; percentage of answers rating 4 or 5 on 5-Likert scale)

4.2 Measures

The model is tested by applying the PLS algorithm which allows for both reflective and formative multi-item measures.

For SOA we applied a reflective measurement instrument consisting of four items (items are listed in Table 12 in the appendix). All other variables were operationalized formatively to take their multidimensionality into account (items are listed in Table 11 in the appendix). For sourcing flexibility, we used four items capturing the four flexibility dimensions specified above. For BPO benefits, we applied 6 items covering the various economic and strategic advantages from BPO; the BPO risks construct was measured by 7 items (cf. Table 5). After conducting initial tests with these formative instruments, we found several high correlations that distorted the weights and deflated their significance levels; this indicates slight multi-collinearity (Mathieson et al. 2001) although all VIFs were below 3 as requested by Petter et al. (2007). Therefore, we decided to apply exploratory factor analyses in order to break both the BPO benefits construct and the BPO risks construct down into multiple smaller instruments, following the suggestion in Cenfetelli and Bassellier (2009) when multi-collinearity is present in formative instruments. For BPO benefits, the factor analysis revealed two components covering operational benefits (Ben1-Ben3) and strategic benefits (Ben4-6). For BPO risks, the factor analysis extracted three components (financial, performance, and strategic risks), cf. Table 5. Table 9 in the appendix shows the results from the factor analyses. In the subsequent model evaluations, the components were simultaneously considered as distinct, still formatively measured, constructs for BPO benefits and BPO risks.

ORIGINAL CONSTRUCT (formative)	ITEM ("Please rate how strongly BPO on basis of SOA would contribute to the following goals / would lead to the appearance of the following issues"):	FINAL CONSTRUCT (split of original constructs based on factor analysis)
BPO benefits	Ben1: Reduction of operations costs	Ben_op (operational BPO benefits)
	Ben2: Quality improvement	
	Ben3: Productivity improvements	
	Ben4: Core competence focus	Ben_strat (strategic BPO benefits)
	Ben5: Access to superior provider know-how	
	Ben6: Access to superior technology	
BPO risks	Risk1: High migration costs	Risk_fin (financial BPO risks)
	Risk2: High coordination costs	
	Risk3: Loss of quality	Risk_perf (performance BPO risks)
	Risk4: Loss of performance	
	Risk5: Long-term loss of own competencies	Risk_strat (strategic BPO risks)
	Risk6: Incomplete contract	
	Risk7: Dependence on provider (lock-in)	

Table 5. Formative measurement of BPO benefits and BPO risks

5 Results

This section provides the results from testing the proposed model with smartPLS 2.0 M3 (Ringle et al. 2007) based on the data collected in the German service industry.

5.1 Measurement Validation

This first sub-section shows that the data exhibits no indications for common method bias and non-response bias, and provides evidence of the sufficient validity and reliability of our measures.

To reduce *common method bias* (CMB) with respect to context bias, different scale formats were used as well as using two different questionnaires with different item orders. A comparison of the answers from both questionnaire versions showed no differences. To test the collected data for CMB, we applied the Harmon single factor test, which revealed that the single factor which shares the largest variance accounts only for 26.3% of the variance shared by all indicators. Further, we added a common method factor proxy to our model, which is measured by a theoretically unrelated marker variable[43] (Lindell and Whitney 2001; Podsakoff et al. 2003). To conduct this CMB test, we added paths from the CMB factor to all dependent variables (i.e., all variables except SOA) and looked at changes in the significances of path weights and R^2. This comparison revealed no change regarding the significance of any of the path weights. The largest absolute delta in R^2 was .012 for Ben_op and the largest delta in path coefficients was .013 for SOA → Ben_op. Altogether, our approach and these results indicate that CMB is not a major concern in our data.

In order to test for the possible existence of *non-response bias* in our data, we followed the approach suggested by Armstrong and Overton (1977), i.e., treating the late respondents as representative of those firms that have not participated at all. Comparing the answers of these late respondents, who had not answered until they received a reminder, with the answers of the direct respondents, showed no significant differences according to the Kolmogorov-Smirnov test.

Our model contains both reflective and formative measures. The reflective measure (i.e., SOA) fulfills the usual requirements regarding reliability (composite reliability > .8) and convergent validity (loadings > .71, AVE > .5) as Table 12 in the appendix shows. Regarding formative measures, there are less formal requirements regarding quality criteria and there are different philosophies regarding the handling of insignificant indicator weights. Since our measures for BPO benefits, BPO risks, and BPO flexibility are thoroughly grounded on theoretical concepts, we decided to leave insignificant items in the model. Since insignificant items add noise but do not increase the signal, they can only weaken the test results. Therefore, our results might be slightly more affected from potential Type II errors by this decision, but not from Type I errors. We will, therefore, discuss rejected hypotheses in detail in section 6. Moreover, Cenfetelli and Bassellier (2009) suggest leaving those formative indicators in the model that show significant correlations with their constructs (i.e., loadings). Table 11 in the appendix shows this to be the case for all of our formative items.

One problem with formative measures is that the score of the construct itself (and thus of the weights) will always depend on the other constructs related with the focal construct (Kim et al. 2010). To take this issue into account, we also used the formative items as reflective measures to test for the potential impact of measurement misspecification (Kim et al. 2010). As Table 10 in the appendix shows, the test results as presented in the next section show to be similar. Finally, we applied the validation procedure suggested by Klein and Rai (2009) to assess discriminant and convergent validity of formative measures. Based on the indicator weights, we calculated a weighted score for each indicator and composite construct scores for each formative construct. These scores are used to calculate the item-to-item and item-to-construct correlations. Overall, we find that all correlations between items of the same construct and between the construct and its items are highly significant ($p \leq .01$) and higher than the inter-construct correlations. Only, two intra-construct correlations within the outsourcing flexibility construct are comparatively lower

[43] The following item was used "Our corporate strategy pursuits increasing customer service/quality."

than the other correlations among the items of this construct. As a result, eight inter-construct/inter-item correlations exist, which are slightly higher than these two intra-construct correlations. However, compared to other works that also used this approach, such as Loch et al. (2003), this is a negligible number of violations. Also, Campbell and Fiske (1959) argue that in a large matrix exceptions are normal and based on the statistical distributions not necessarily meaningful. Thus, as only 8 out of 253 correlations in the matrix[44] are slightly higher than expected, we conclude that the formative measures fulfill convergent and discriminant validity to a sufficient degree.

The first-order constructs measuring the five different benefit dimensions and risk dimensions were further aggregated to two second-order constructs in order to examine their commonality. The path coefficients between the first-order and second-order constructs are well balanced and each dimension contributes highly significant to the composite construct.

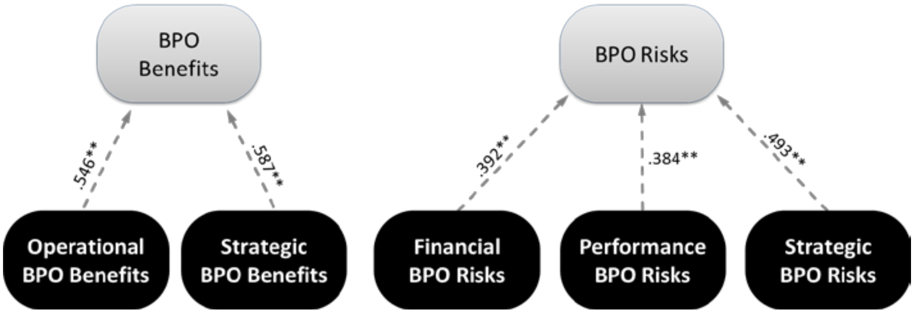

Figure 5. Path coefficients from first-order to second-order constructs (: p ≤ .01)**

5.2 Model Test

The model test follows a hierarchical procedure to test for the mediation effect proposed by Hypothesis 5. The first model consists of BPO benefits, BPO risks, and SOA. Model 2 adds sourcing flexibility as mediator and thus represents the full model.

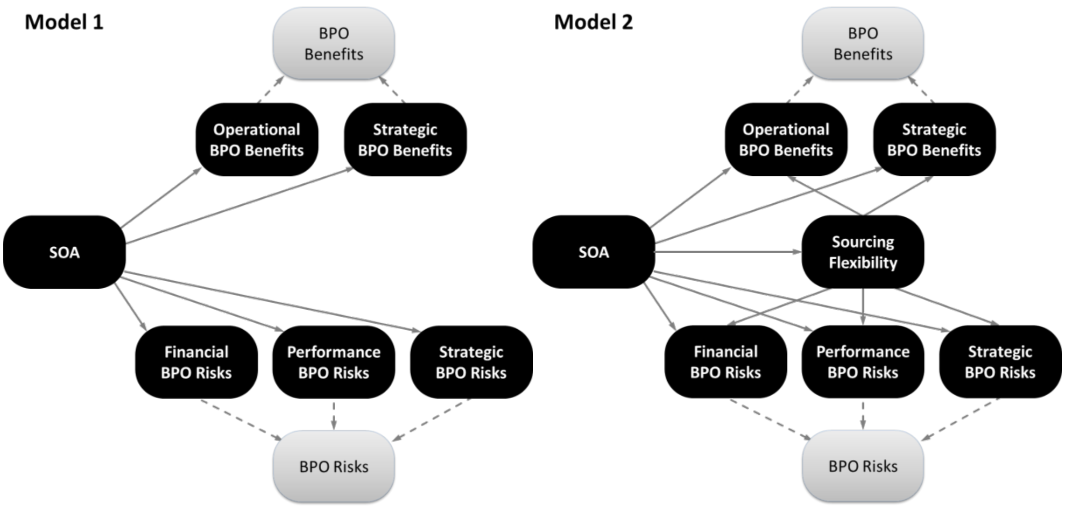

Figure 6. PLS models

44 Due to limited space, the entire matrix containing all item-to-item and item-to-construct correlations was not included in the paper but can be obtained from the authors upon request.

Both models allow for the testing of hypotheses 2 and 3. Model 2 additionally tests hypotheses 1 and 4 while the comparison of both models gives evidence about the mediation effects proposed by hypothesis 5. The following table provides the PLS estimation results (paths and R^2).

R^2, Path coefficients, and levels of significance	Model 1	Model 2
Sourcing flexibility → Ben_op (operational BPO benefits)		**.382****
Sourcing flexibility → Ben_strat (strategic BPO benefits)		**.346****
Sourcing flexibility → Risk_fin (financial BPO risks)		**-.247***
Sourcing flexibility → Risk_perf (performance BPO risks)		**-.395****
Sourcing flexibility → Risk_strat (strategic BPO risks)		**-.256***
SOA → Ben_op (operational BPO benefits)	**.222***	**.151***
SOA → Ben_strat (strategic BPO benefits)	.070	.012
SOA → Risk_fin (financial BPO risks)	**-.180***	-.132
SOA → Risk_perf (performance BPO risks)	-.027	.047
SOA → Risk_strat (strategic BPO risks)	**-.270****	**-.214***
SOA → Sourcing flexibility		**.190***
R^2 Ben_op (operational BPO benefits)	.049	.191
R^2 Ben_strat (strategic BPO benefits)	.005	.122
R^2 Risk_fin (financial BPO risks)	.032	.091
R^2 Risk_perf (performance BPO risks)	.001	.151
R^2 Risk_strat (strategic BPO risks)	.073	.132
R^2 Sourcing flex		.036
Sample size (n)	115	115

Table 6. Results from the model tests (: $p \leq .01$, *: $p \leq .05$)**

The results show that SOA affects perceived operational BPO benefits but not strategic benefits, and it reduces perceived financial risks and strategic risks, but not performance risks. The role of sourcing flexibility is as proposed: it drives BPO benefits but reduces BPO risks and it is positively affected by SOA.

To test the mediation effect regarding sourcing flexibility, we conducted the Sobel z-Test (Shrout and Bolger 2002) and bootstrapped the sampling distribution as suggested by Preacher and Hayes (2004). Both tests were conducted only for those potential mediation effects, for which the direct paths from SOA to the respective BPO decision determinant had been significant in Model I (cf. Table 6). Table 7 shows the results of the Sobel test including the variance accounted for (VAF) and the bootstrap-based results (i.e., boundaries of the confidence intervals and point estimates). According to the Sobel test, the mediation of SOA's effect on Ben_op and Risk_strat by sourcing flexibility is marginally significant and each account for 13% of SOA's effect. We also bootstrapped the sampling distributions to counteract the problem that the indirect effects are often not normally distributed (Hayes 2009). Thus, the results based on 2,000 bootstrap samples are more reliable than the Sobel test results. Table 7 presents the lower and upper bounds of the 95% and 99% confidence intervals and the point estimates with their levels of significance. Overall, the bootstrap-based results reveal higher levels of significance than the Sobel z-Test and support the mediating effect of sourcing flexibility for SOA's impact on operational benefits (.084), financial risks (-.054), and strategic risks (-.026).

	Sobel z-Test		Bootstrap-based test		
	Sobel z-Test	VAF	Lower bound	Upper bound	Point estimate
SOA → sourcing flexibility → Ben_op	**1.31^{+}**	**.13**	**.002****	**.230****	**.084**
SOA → sourcing flexibility → Risk_fin	-1.24	.12	**-.140***	**-.002***	**-.054**
SOA → sourcing flexibility → Risk_strat	**-1.42^{+}**	**.13**	**-.076***	**-.001***	**-.026**

Table 7. Results of mediation analysis (: $p \leq .01$, *: $p \leq .05$, $^{+}$: $p \leq .1$)**

The following table summarizes all results, which are discussed in the next chapter.

Hypothesis:	Result:	Comment:
1a: Sourcing Flexibility → BPO Benefits	Confirmed	
1b: Sourcing Flexibility → BPO Risks	Confirmed	
2: SOA→ BPO Benefits	Partly confirmed	Significant relationship with operational benefits but not with strategic benefits
3: SOA → BPO Risks (negative)	Partly confirmed	Significant relationship with financial risks and strategic risks but not with performance risks
4: SOA → Sourcing Flexibility	Confirmed	
5a: Sourcing Flexibility mediates relationship between SOA and perceived BPO Benefits.	Partly confirmed	Introducing sourcing flexibility to the model slightly but significantly reduces the strength of the direct path from SOA to operational benefits. This validates sourcing flexibility as a *partial* mediator for this particular relationship.
5b: Sourcing Flexibility mediates relationship between SOA and perceived BPO Risks.	Partly confirmed	Introducing sourcing flexibility to the model reduces the strengths of the direct paths from SOA to financial and strategic risks. This validates sourcing flexibility as a *partial* mediator for these particular relationships.

Table 8. Test results

6 Discussion and Conclusion

We have developed and empirically tested a research model which explains how a firm's SOA influences the perceived benefits and risks of BPO, and thus the intention to outsource distinct business processes.

6.1 Discussion

While our theoretical model was largely confirmed by empirical data, a few of the proposed hypotheses did not hold true in the empirical evaluation process:

- **SOA and BPO benefits:** SOA is not positively related to perceived strategic benefits: Strategic benefits seem not to be a major argument in selective SOA-based outsourcing of single business functions. The main pros are of an operational nature (cost reduction, quality and productivity improvement). Strategic BPO benefits (core competencies focus, access to superior vendor know-how) can be achieved with or without SOA. By contrast, operational benefits are increased by SOA because SOA facilitates the separation of the particular business function from the client and its transfer to the vendor firm and it also – due to increasing modularity – facilitates selective sourcing of different business functions to different, best-suited vendors, which in turn can maximize economies of skill and scale (Beimborn 2008).

- **SOA and BPO risks:** SOA is not negatively related to perceived performance risks (loss of quality and performance): From the outsourcing firm's perspective, loss of quality and performance usually are related to insufficient competencies or an absence of willingness to fulfill by the outsourcing vendor. Since SOA only facilitates outsourcing from a technical and organizational perspective but does not avoid the threat of selecting an incapable partner, it does not reduce this perception of performance risks. But, due to increased modularity and more selective sourcing, SOA reduces the strategic risks of lock-in since backsourcing or changing the vendor will be easier in the event of poor performance.
- **SOA and sourcing flexibility:** Sourcing flexibility only slightly mediates the relationship between SOA and operational benefits, financial risks, and strategic risks. Sourcing flexibility is one explanation factor of why SOA increases perceived BPO benefits and reduces perceived BPO risks but there remains space for additional complementary explanations. One of these could simply be the fact that SOA leads to a more modular perspective on doing business. A modularity perspective on how a firm generates value opens the eyes to outsourcing opportunities – just as product modularization increased outsourcing and industrialization in manufacturing processes several decades ago. Another argument is related to the technical level: SOA involves standards (e.g., the family of Web Services standards like SOAP, WSDL, and BPEL) which allow the interaction and integration of the implemented business services. Using standards increases opportunities for inter-firm collaboration (Weitzel et al. 2006) which also covers BPO opportunities.

The discussion shows that the differentiation of BPO benefits and risks into multiple categories uncovered the particular role SOA has in the BPO context. It increases IT modularity and thus facilitates BPO by increasing sourcing flexibility, and in particular it increases operational benefits and lowers financial as well as strategic risks. SOA contributes to an "industrialization" of IT-enabled business processes by modularizing the "processing infrastructure" and leading to higher degrees of outsourcing certain business functions to specialized firms which, due to sourcing economies (economies of scale, learning effects etc.) can provide superior service at lower costs. Nevertheless, it is not only about modularizing the IT infrastructure. The benefits can only be achieved if the implemented SOA-based services are aligned with the modularity of the business process level, i.e., services have to resemble modular (and thus outsourceable) business functions. If the SOA consists of services that are more coarse-grained than the business functions which are considered to be outsourced than our arguments cannot hold true. The comprehensive conceptualizations of SOA already take this need for modularity alignment into account and define SOA as "framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services". (Bieberstein et al. 2005a, p. 5).

6.2 Limitations and Future Research

One of the main limitations of our study is the still rather immature degree of SOA adoption in the industry, i.e., the firms' IT infrastructures being reconfigured based the SOA paradigm. Although SOA has become a prevalent concept in the scientific and practitioner literature over the last years, changing IT infrastructures in a brown-field approach is one of the most complex and most expensive issues in the IT field. We subsequently expect much richer data in future years and hope that our suggested model can be useful in helping better understand *how* SOA can affect business processes and value. Due to low adoption rates it did not make sense to capture the *outcomes* of BPO in our research. Although the perceived benefits, risks, and sourcing flexibility might drive BPO activities, today there is no evidence as to whether BPO based on SOA is more successful or not in terms of *realizing* the anticipated benefits or avoiding the risks more successfully. When SOA-based BPO has matured in the field, future research should study these phenomena and in particular look at possible substitution effects, among others.

Our approach has captured several variables using formative measurement instruments. As argued above, rich concepts like BPO benefits, risks, or flexibility are, by definition, multidimensional which should be reflected by the instruments. Our instruments showed some minor problems regarding potential multicollinearity but this did not affect the structural results (Cenfetelli and Bassellier 2009). We re-calculated the models with reflective measurement models and the comparison showed that our results remain stable. However, the noise created by insignificant formative items together with a rather limited sample size and thus limited statistical power might have led to type-II-errors, i.e., where the relationship between constructs is not found to be significant although they actually are. But, since the path coefficients of the rejected hypotheses are very small or tend towards zero (e.g., .07 and -.027 in Model 1) we believe that type-II-errors are very unlikely. Finally, our approach used a single key-informant source for data collection, i.e., the leading IT architect, who is best placed to answer the questions regarding the current status of SOA adoption. However s/he might not have a complete picture when judging the BPO related items. Although this key informant approach is common in organizational and IS research, problems of common method variance and perceptional biases regarding the object of analysis can be a serious drawback. We used several procedures to safeguard our findings, such as careful questionnaire design with varying item orders, accompanying case studies of firms that have implemented SOA, and comprehensive CMB detection analytics; but, one can never be sure that CMB issues have been completely eliminated. Moreover, in our context it would have been quite impossible to identify alternative sources in the firms that have the same level of understanding and share the same perspectives on IT architectures other than the leading IT architect or IT lead.

6.3 Contributions and Conclusion

The model and empirical analyses have shown how SOA will potentially affect BPO. By combining arguments from the two different research domains on the business impact of SOA and the quest for IT-related BPO success factors, we offer a new perspective on how the modularity of the IT architecture affects the redesign of organizational structures and eventually the borders of firms.

Regarding BPO research, our results extend the findings of previous studies on the drivers and inhibitors of BPO by revealing the role of IT, in particular SOA. For SOA research, we offer a first empirical evaluation of a business value aspect of SOA, which has not been considered so far (i.e., facilitation of BPO). Together, the dual perspective on SOA and BPO suggests perpetuating outsourcing growth in the future with increasing maturity of related research especially on SOA governance (Joachim et al. 2011a; Joachim et al. 2011d) and SOA maturity (Joachim et al. 2011c). From a managerial perspective, the analyses reveal that IT architecture modularity should be taken into greater account as an outsourcing readiness component, since it affects sourcing flexibility and related decision determinants. However, there remains a need for an extended alignment perspective that harmonizes modules/services at the technical and business process level.

Altogether, we hope that our research contributes to an increased understanding of the interplay between IT architectures and (inter-)organizational designs, and how IT architectures contribute to reshaping a firm's borders.

7 References

Abramovsky, L. and Griffith, R. 2006. "Outsourcing and offshoring of business services: How important is ICT?", *Journal of the European Economic Association* (4:2/3), pp. 594–601.

Anand, N. and Daft, R.L. 2007. "What is the right organization design?", *Organizational Dynamics* (36:4), pp. 329–344.

Ang, S. and Cummings, L. 1997. "Strategic response to institutional influence on information systems outsourcing", *Organization Science* (8:3), pp. 235-256.

Ang, S. and Straub, D.W. 1998. "Production and transaction economies and IS outsourcing: A study of the U.S. banking industry", *MIS Quarterly* (22:4), pp. 535-552.

Apte, U.M., Sobol, M.G., Hanaoka, S., and Shimada, T. 1997. "IS outsourcing practices in the USA, Japan, and Finland: A comparative study", *Journal of Information Technology* (12:4), pp. 289-304.

Armstrong, J.S. and Overton, T.S. 1977. "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research* (14:3), pp. 396–402.

Aubert, B.A., Dussault, S., Rivard, S., and Patry, M. 1999. "Managing the risk of IT outsourcing", *Proceedings of the 32nd Hawaii International Conference on System Sciences (HICSS),* Wailea, Maui, HI, USA.

Avison, D., Powell, P., Keen, P., Klein, J., and Ward, S. 1995. "Addressing the need for flexibility in information systems", *Journal of Management Information Systems* (7:2), pp. 43-60.

Bahli, B. and Rivard, S. 2004. "Validating measures of information technology outsourcing risk factors", *Omega* (33:2), pp. 175-187.

Baldwin, C.Y. and Clark, K.B. 2000. *Design rules: The power of modularity*. Cambridge, MA: MIT Press.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Basu, A. and Blanning, R.W. 2003. "Synthesis and decomposition of processes in organizations", *Information Systems Research* (14:4), pp. 337–355.

Beimborn, D. 2008. *Cooperative sourcing - simulation studies and empirical data on outsourcing coalitions in the banking industry*. Wiesbaden: Gabler.

Beimborn, D. and Joachim, N. 2011. "The joint impact of service-oriented architectures and business process management on business process quality: An empirical evaluation and comparison", *Information Systems and e-Business Management* (9:3), pp. 333–362.

Beimborn, D., Joachim, N., and Weitzel, T. 2008. "Drivers and inhibitors of SOA business value – conceptualizing a research model", in: *Proceedings of the 14th Americas Conference on Information Systems (AMCIS)*. Toronto, ON, Canada.

Benazeer, M.S., Verelst, J., Grembergen, V.W., and Mannaert, H. 2008. "Aligning technology with business an analysis of the impact of SOA on outsourcing", *Journal of Theoretical and Applied Information Technology* (4:3), pp. 244–252.

Bieberstein, N., Bose, S., Fiammante, M., Jones, K., and Shah, R. 2005a. *Service-oriented architecture (SOA) compass: Business value, planning, and enterprise roadmap*. Upper Saddle River, NJ: IBM Press.

Bieberstein, N., Bose, S., Walker, L., and Lynch, A. 2005b. "Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals", *IBM Systems Journal* (44:4), pp. 691–708.

Braun, M. 2004. "Vom IT- zum Business Process Outsourcing", *Bankmagazin* (53:2), p. 22.

Campbell, D.T. and Fiske, D.W. 1959. "Convergent and discriminant validation by the multitrait-multimethod matrix", *Psychological Bulletin* (56:2), pp. 81-10.

Cenfetelli, R.T. and Bassellier, G. 2009. "Interpretation of formative measurement in information systems research", *MIS Quarterly* (33:4), pp. 689–707.

Cheon, M.J., Grover, V., and Teng, J.T.C. 1995. "Theoretical perspectives on the outsourcing of information systems", *Journal of Information Technology* (10:4), pp. 209-219.

Cunningham, S.M. 1967. "The major dimensions of perceived risk", in: *The major dimensions of perceived risk, risk taking and information handling in consumer behaviour,* D.F. Cox (ed.). Boston (MA): Harvard University Press, pp. 82-108.

Davenport, T.H. 2005. "The coming commoditization of processes", *Harvard Business Review* (83:6), pp. 100-108.

Dawes, J. 2008. "Do data characteristics change according to the number of scale points used?", *International Journal of Market Research* (50:1), pp. 61–77.

Dayasindhu, N. 2004. "Information technology enabled process outsourcing and reengineering: Case study of a mortgage bank", *Proceedings of the 10th Americas Conference on Information Systems (AMCIS),* New York, NY, USA.

Dibbern, J., Goles, T., Hirschheim, R., and Jayatilaka, B. 2004. "Information systems outsourcing: A survey and analysis of the literature", *The DATA BASE for Advantages in Information Systems* (35:4), pp. 6-102.

Duncan, R. 1979. "What is the right organization structure? Decision tree analysis provides the answer", *Organizational Dynamics* (7:3), pp. 59–80.

Earl, M.J. 1996. "The risks of outsourcing IT", *Sloan Management Review* (37:3), pp. 26-32.

Erl, T. 2004. *Service-oriented architecture: A field guide to integrating XML and web services*. Upper Saddle River, NJ: Prentice Hall.

Ernst, R. and Kamrad, B. 2000. "Evaluation of supply chain structures through modularization and postponement", *European Journal of Operational Research* (124:3), pp. 495–510.

Gewald, H. and Dibbern, J. 2009. "Risks and benefits of business process outsourcing: A study of transaction services in the german banking industry", *Information & Management* (46:4), pp. 249–257.

Gewald, H., Wüllenweber, K., and Weitzel, T. 2006. "The influence of perceived risks on banking managers' intention to outsource business processes - a study of the german banking and finance industry", *Journal of Electronic Commerce Research* (7:2), pp. 78-96.

Goolsby, K. 2008. "New impacts on outsourcing in 2009", in: *Outsourcing Journal* (11).

Grover, V., Cheon, M.J., and Teng, J.T.C. 1996. "The effect of service quality and partnership on the outsourcing of information systems functions", *Journal of Management Information Systems* (12:4), pp. 89-116.

Hayes, A. 2009. "Beyond Baron and Kenny: Statistical mediation analysis in the new millennium", *Communication Monographs* (76:4), pp. 408–420.

Heutschi, R. 2007. *Serviceorientierte Architektur - Architekturprinzipien und Umsetzung in die Praxis*. Berlin, Heidelberg, New York, NY: Springer.

Hoetker, G. 2006. "Do modular products lead to modular organizations?", *Strategic Management Journal* (27:6), pp. 501-518.

Hsu, C.-C. and Wu, C.-H. 2006. "The evaluation of the outsourcing of information systems: A survey of large enterprises", *International Journal of Management* (23:4), pp. 817-830.

Huber, R.L. 1993. "How continental bank outsourced its crown jewels", *Harvard Business Review* (71:1), pp. 121-129.

Janssen, M. and Joha, A. 2008. "Emerging shared service organizations and the service-oriented enterprise: Critical management issues", *Strategic Outsourcing: An International Journal* (1:1), pp. 35–49.

Joachim, N., Beimborn, D., Schlosser, F., and Weitzel, T. 2011a. "Does SOA create or require IT/business collaboration? Investigating SOA's potential to reduce the gap between IT and business", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*. Shanghai, China.

Joachim, N., Beimborn, D., and Weitzel, T. 2011b. "Eine empirische Untersuchung des Wertbeitrages von serviceorientierten Architekturen (SOA)", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Joachim, N., Beimborn, D., and Weitzel, T. 2011c. "An instrument for measuring SOA maturity", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*. Shanghai, China.

Joachim, N., Beimborn, D., and Weitzel, T. 2011d. "SOA-governance für effektive serviceorientierte Architekturen – Eine empirische Studie in der deutschen Dienstleistungswirtschaft", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Kakabadse, A. and Kakabadse, N. 2002. "Trends in outsourcing - contrasting USA and Europe", *European Management Journal* (20:2), pp. 189-198.

Kim, G.-M. and Kim, S.-Y. 2008. "Exploratory study on effective control structure in global business process sourcing", *Information Resource Management Journal* (21:3), pp. 101-118.

Kim, G., Shin, B., and Grover, V. 2010. "Investigating two contradictory views of formative measurement in information systems research", *MIS Quarterly* (34:2), pp. 345-A345.

King, W.R., Liu, C.Z., Haney, M.H., and He, J. 2007. "Method effects in IS survey research: An assessment and recommendations", *Communications of the Association for Information Systems* (20:1), pp. 457–482.

Klein, R. and Rai, A. 2009. "Interfirm strategic information flows in logistics supply chain relationships", *MIS Quarterly* (33:4), pp. 735–762.

Krafzig, D., Banke, K., and Slama, D. 2005. *Enterprise SOA: Service-oriented architecture best practices*. Upper Saddle River, NJ: Prentice Hall.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007. "SOA and information sharing in supply chain: “How” information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Lacity, M.C., Khan, S.A., and Willcocks, L. 2009. "A review of the IT outsourcing literature: Insights for practice", *Journal of Strategic Information Systems* (18:3), pp. 130-146.

Lacity, M.C. and Willcocks, L.P. 2001. *Global information technology outsourcing: In search of business advantage*. Chichester: John Wiley & Sons.

Lammers, M. 2004. "Make, buy or share - combining resource based view, transaction cost economics and production economies to a sourcing framework", *Wirtschaftsinformatik* (46:3), pp. 204–212.

Langlois, R.N. 2002. "Modularity in technology and organization", *Journal of Economic Behavior and Organization* (49:1), pp. 19-37.

Lee, J.-N. and Kim, Y.-G. 1999. "Effect of partnership quality on IS outsourcing success: Conceptual framework and empirical validation", *Journal of Management Information Systems* (15:4), pp. 29-61.

Lim, B. and Wen, H.J. 2003. "Web services: An analysis of the technology, its benefits, and implementation difficulties", *Information Systems Management* (20:2), pp. 49-49.

Lindell, M.K. and Whitney, D.J. 2001. "Accounting for common method variance in cross-sectional research designs", *Journal of Applied Psychology* (86:1), pp. 114–121.

Loch, K.D., Straub, D.W., and Kamel, S. 2003. "Diffusing the internet in the Arab world: The role of social norms and technological culturation", *IEEE Transactions on Engineering Management* (50:1), pp. 45–63.

Loh, L. and Venkatraman, N. 1992a. "Determinants of information technology outsourcing: A cross-sectional analysis", *Journal of Management Information Systems* (9:1), pp. 7-24.

Loh, L. and Venkatraman, N. 1992b. "Diffusion of IT outsourcing: Influence sources and the Kodak effect", *Information Systems Research* (3:4), pp. 334-358.

Mani, D., Barua, A., and Whinston, A.B. 2006. "Successfully governing business process outsourcing relationships", *MIS Quarterly Executive* (5:1), pp. 15-29.

Martin, S., Beimborn, D., Parikh, M.A., and Weitzel, T. 2008. "Organizational readiness for business process outsourcing: A model of determinants and impact on outsourcing success", *Proceedings of the 41st Hawaii International Conference on System Sciences (HICSS),* Waikoloa, Big Island, HI, USA.

Mathieson, K., Peacock, E., and Chin, W. 2001. "Extending the technology acceptance model: The influence of perceived user resources", *The DATA BASE for Advances in Information Systems* (32:3), pp. 86-112.

McFarlan, F. and Nolan, R. 1995. "How to manage an IT outsourcing alliance", *Sloan Management Review* (36:2), pp. 9-23.

Mikkola, J.H. 2003. "Modularity, component outsourcing, and inter-firm learning", *R&D Management* (33:4), pp. 439–454.

Mithas, S. and Whitaker, J. 2007. "Is the world flat or spiky? Information intensity, skills, and global service disaggregation", *Information Systems Research* (18:3), pp. 237–259.

Momme, J., Moeller, M.M., and Hvolby, H.-H. 2000. "Linking modular product architecture to the strategic sourcing process: Case studies of two danish industrial enterprises", *International Journal of Logistics: Research & Applications* (3:2), pp. 127–146.

Müller, J., Jostock, F., Götze, J., and Müller, P. 2008. "Workflow Monitoring in Service-orientierten Architekturen", in: *Service-orientierte Architekturen - Chancen und Herausforderungen bei der Flexibilisierung und Integration von Unternehmensprozessen,* V. Nissen, M. Petsch, and H. Schorscht (eds.). Wiesbaden, Germany: Gabler, pp. 185-204.

Münstermann, B., Joachim, N., and Beimborn, D. 2009. "An empirical evaluation of the impact of process standardization on process performance and flexibility", *Proceedings of the 15th Americas Conference on Information Systems (AMCIS),* San Francisco, CA, USA.

Oh, L.-B., Leong, Y.-X., Teo, H.-H., and Ravichandran, T. 2007. "Service-oriented architecture and organizational integration: An empirical study of IT-enabled sustained competitive advantage", in: *Proceedings of the 28th International Conference on Information Systems (ICIS).* Montreal, QC, Canada.

Papazoglou, M.P. and Heuvel, W.-J. 2007. "Service oriented architectures: Approaches, technologies and research issues", *The VLDB Journal* (16:3), pp. 389–415.

Petter, S., Straub, D., and Rai, A. 2007. "Specifying formative constructs in information systems research", *MIS Quarterly* (31:4), pp. 623–656.

Pfannenstein, L.L. and Ray, J.T. 2004. "Offshore outsourcing: Current and future effects on american IT industry", *Information Systems Management* (21:4), pp. 72-80.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. 2003. "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Psychology* (88:5), pp. 879–903.

Preacher, K.J. and Hayes, A.F. 2004. "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods* (36:4), pp. 717–731.

Quinn, J.B. and Hilmer, F.G. 1994. "Strategic outsourcing", *Sloan Management Review* (35:4), pp. 43-55.

Ren, M. and Lyytinen, K.J. 2008. "Building enterprise architecture agility and sustenance with SOA", *Communications of the Association for Information Systems* (22:1), pp. 75–86.

Ringle, C.M., Wende, S., and Will, A. 2007. "SmartPLS 2.0 (M3) Beta". Hamburg.

Ro, Y.K., Liker, J.K., and Fixson, S.K. 2007. "Modularity as a strategy for supply chain coordination: The case of U.S. auto", *IEEE Transactions on Engineering Management* (54:1), pp. 172–189.

Sanchez, R. and Mahoney, J.T. 1996. "Modularity, flexibility, and knowledge management in product and organization design", *Strategic Management Journal* (17:Winter Special Issue), pp. 63–76.

Schilling, M.A. 2000. "Toward a general modular systems theory and its application to interfirm product modularity", *Academy of Management Review* (25:2), pp. 312–334.

Schulte, S., Repp, N., Eckert, J., Berbner, R., Blanckenburg, K., Schaarschmidt, R., and Steinmetz, R. 2008. "General requirements of banks on IT architectures and the service-oriented architecture paradigm", in: *Enterprise Applications and Services in the Finance Industry,* D.J. Veit, D. Kundisch, T. Weitzel, C. Weinhardt, F.A. Rabhi, and F. Rajola (eds.). Berlin: Springer, pp. 66–80.

Shrout, P. and Bolger, N. 2002. "Mediation in experimental and nonexperimental studies: New procedures and recommendations", *Psychological Methods* (7:4), pp. 422–445.

Siedersleben, J. 2007. "SOA revisited: Component orientation in system landscapes", *Wirtschaftsinformatik* (49:Special Issue), pp. 110–117.

Simon, H.A. 1962. "The architecture of complexity", *Proceedings of the American Philosophical Society*, pp. 467-482.

Slaughter, S. and Ang, S. 1996. "Employment outsourcing in information systems", *Communications of the ACM* (39:7), pp. 47-54.

Smith, M., Mitra, S., and Narasimhan, S. 1998. "Information systems outsourcing: A study of pre-event firm characteristics", *Journal of Management Information Systems* (15:2), pp. 61-93.

Takeishi, A. 2002. "Knowledge partitioning in the inter-firm division of labor: The case of automotive product development", *Organization Science* (13:3), pp. 321-338.

Tan, C. and Sia, S.K. 2006. "Managing flexibility in outsourcing", *Journal of the Association for Information Systems* (7:4), pp. 179-206.

Tanriverdi, H., Konana, P., and Ge, L. 2007. "The choice of sourcing mechanisms for business processes", *Information Systems Research* (18:3), pp. 280–299.

Tiwana, A. 2008. "Does technological modularity substitute for control? A study of alliance performance in software outsourcing", *Strategic Management Journal* (29:7), pp. 769-780.

Tiwana, A. and Konsynski, B. 2010. "Complementarities between organizational IT architecture and governance structure", *Information Systems Research* (21:2), pp. 288-304.

Umar, A. 2005. "IT infrastructure to enable next generation enterprises", *Information Systems Frontiers* (7:3), pp. 217–256.

vom Brocke, J. and Lindner, M.A. 2004. "Service portfolio measurement: A framework for evaluating the financial consequences of out-tasking decisions", *Proceedings of the 2nd International Conference on Service-Oriented Computing (ICSOC),* New York, NY, USA.

vom Brocke, J. and Sonnenberg, C. 2008. "Serviceorientiertes Prozesscontrolling - Unternehmensindividuelle Wirtschaftlichkeitsrechnungen zur Nutzung serviceorientierter Architekturen bei der Prozessgestaltung", in: *Service-orientierte Architekturen - Chancen* *und Herausforderungen bei der Flexibilisierung und Integration von Unternehmensprozessen,* V. Nissen, M. Petsch, and H. Schorscht (eds.). Wiesbaden, Germany: Gabler, pp. 185-204.

Weitzel, T., Beimborn, D., and König, W. 2006. "A unified economic model of standard diffusion: The impact of standardization cost, network effects, and network topology", *MIS Quarterly* (30:Special Issue), pp. 489–514.

Willcocks, L.P., Hindle, J., Feeny, D.F., and Lacity, M.C. 2004. "IT and business process outsourcing: The knowledge potential", *Information Systems Management* (21:4), pp. 7-15.

Wüllenweber, K., Beimborn, D., Weitzel, T., and König, W. 2008. "The impact of process standardization on BPO success", *Information Systems Frontiers* (10:2), pp. 211-224.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

Young-Ybarra, C. and Wiersema, M. 1999. "Strategic flexibility in information technology alliances: The influence of transaction cost economics and social exchange theory", *Organization Science* (10:4), pp. 439-459.

Zhao, J., Tanniru, M., and Zhang, L.-J. 2007. "Services computing as the foundation of enterprise agility: Overview of recent advances and introduction to the special issue", *Information Systems Frontiers* (9:1), pp. 1–8.

8 Appendix

Item	Ben_op	Ben_strat	Risk_fin	Risk_perf	Risk_strat
Ben1	**.842**	.214			
Ben2	**.854**	.118			
Ben3	**.853**	.206			
Ben4	.528	**.570**			
Ben5	.146	**.931**			
Ben6	.173	**.894**			
Risk1			**.867**	.080	.192
Risk2			**.765**	.330	.133
Risk3			.153	**.891**	.148
Risk4			.211	**.822**	.156
Risk5			.070	.426	**.643**
Risk6			.294	-.005	**.690**
Risk7			.075	.159	**.815**

Table 9. Exploratory factor analyses of (a) BPO benefits items (components with Eigenvalue > 1.0) and (b) BPO risks items (components with Eigenvalue > .93)

To test for the stability of the results in light of formative measurement, we re-calculated both models by inverting the formative measurement models to reflective mode. Table 10 compares the results with those from calculations from the original models (results from Table 6). This shows that our results remain stable and thus gives further evidence for the validity of our findings.

R^2, path coefficients, and levels of significance	Model 1	Model 1 with reflective constructs	Model 2	Model 2 with reflective constructs
Sourcing flexibility →Ben_op			**.382****	**.373****
Sourcing flexibility → Ben_strat			**.346****	**.354****
Sourcing flexibility → Risk_fin			**-.247***	**-.259****
Sourcing flexibility → Risk_perf			**-.395****	**-389****
Sourcing flexibility → Risk_strat			**-.256***	**-.254****
SOA →Ben_op	**.222***	**.210***	**.151***	**.153***
SOA → Ben_strat	.070	.089	.012	.034
SOA → Risk_fin	**-.180***	**-.174***	-.132	-.134
SOA → Risk_perf	-.027	-.032	.047	.029
SOA → Risk_strat	**-.270****	**-.184***	**-.214***	**-.148***
SOA → Sourcing flexibility			**.190***	**.156***
R^2 Ben_op	.049	.044	.191	.180
R^2 Ben_strat	.005	.008	.122	.131
R^2 Risk_fin	.032	.030	.091	.096
R^2 Risk_perf	.001	.001	.151	.149
R^2 Risk_strat	.073	.034	.132	.098
R^2 Sourcing flex			.036	.024
Sample size (n)	115	115	115	115

Table 10. Comparison of original model calculations with model based on reflective construct measurement and with partial model calculation (: $p \leq .01$, *: $p \leq .05$)**

Construct	Item	Text (original items were in German and measured based on 5-step Likert scale)	Weight	Outer loading	References
Ben_op (operational benefits)	Ben1	Business process cost reduction	.551**	.931**	(Hsu and Wu 2006; Lee and Kim 1999)
	Ben2	Quality improvement (processing time, reduced error rates)	.236	.802**	
	Ben3	Productivity improvement	.343*	.868**	
Ben_strat (strategic benefits)	Ben4	Core competence focus	.670**	.900**	
	Ben5	Access to superior know-how of the provider	.027	.756**	
	Ben6	Access to superior technology	.472*	.798**	
Risk_fin (financial risks)	Risk1	High migration costs	.377*	.758**	(Gewald and Dibbern 2009; Hsu and Wu 2006)
	Risk2	High coordination costs for controlling provider	.755**	.945**	
Risk_perf (performance risks)	Risk3	Loss of quality	.592**	.924**	
	Risk4	Loss of performance	.507**	.894**	
Risk_strat (strategic risks)	Risk5	Long-term loss of own competencies	.785**	.933**	
	Risk6	Incomplete contract	.342**	.699**	
	Risk7	Dependence on provider	.103	.572**	
Perceived sourcing flexibility	Sfl1	The BPO provider can react to exceptions in process execution without increasing costs.	-.009	.498**	(Tan and Sia 2006)
	Sfl2	Outsourced business processes can be adapted fast and cost-efficient.	.683**	.938**	
	Sfl3	New functionality can be added to outsourced processes quickly and at low price.	.277+	.809**	
	Sfl4	For us the amount of relevant BPO providers, which offer mature services, is high.	.267+	.521**	

Table 11. Formative measurement instruments (: p ≤ .01, *: p ≤ .05, $^{+}$: p ≤ .1)**

Construct	Item	Text (original items were in German and measured by 7-step Likert scale[45])	Loading	Composite reliability	AVE
SOA	SOA1	Our firm has realized its IT architecture in an SOA-oriented manner.	.927**	.959 (Cronbach's α = .945)	.855
	SOA2	Our IT landscape follows the SOA paradigm as far as possible.	.928**		
	SOA3	Service orientation is the primary design principle of our IT architecture.	.926**		
	SOA4	All of our applications are integrated via service-oriented interfaces.	.916**		

Table 12. Reflective measurement instrument (: p ≤ .01)**

[45] Since SOA is newer than BPO, we used 7-point scales in order to ensure sufficient variability within these items. To reduce complexity for the respondents we used 5-point scales (King et al. 2007) for the BPO-related items. After rescaling 5-point and 7-point scales deliver the same mean scores (Dawes 2008).

PAPER VII

THE INFLUENCE OF SOA GOVERNANCE MECHANISMS ON IT FLEXIBILITY AND SERVICE REUSE

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Abstract

While many firms have introduced SOA, only one in five have achieved anticipated benefits such as increased IT flexibility or reuse. Industry analysts assume that a lack of SOA governance is the main reason why SOA projects fail. Addressing the substantial research gap on SOA governance this paper theoretically and empirically investigates which SOA governance mechanisms are needed to achieve the benefits of SOA, such as increasing IT flexibility and reusing services. The proposed theoretical SOA governance model is evaluated using data from 81 SOA-using organizations.

Overall, the results confirm the relevance of a variety of SOA governance mechanisms (structures, processes, and employees/relations), but at the same time, that IT infrastructure flexibility and service reuse are influenced by different mechanisms. Key governance mechanisms that show a strong effect on infrastructure flexibility are using standards, service management processes, educating employees, and IT/business communication while reuse can only be increased through service management, standards and qualification. Contrary to expectations, implementing new, dedicated decision-making bodies for SOA hampers organizations in achieving higher degrees of IT flexibility and reuse, and a firm is better off using existing IT decision-making bodies.

1 Introduction

Many firms report that their SOA projects have failed to realize the expected benefits from servitization. Industry analysts propose that the "*main reason SOA projects fail is because there is a lack of governance*" (Saran 2006). As the maturing academic literature on development and implementation of service-oriented architectures (SOAs) has so far mostly investigated important *technical* aspects of SOA, there is a dearth of research on SOA *governance* and its mechanisms. A recent literature review reveals that "organization and governance" is addressed in only 4 out of 175 SOA research articles and calls for future research on "how organizations should apply the SOA concept" (Viering et al. 2009, p. 46). The importance of SOA governance also comes up in a Forrester Research study, which finds that only 20 percent of surveyed organizations achieve all anticipated SOA benefits, while 50 percent achieve less or struggle to reap the expected benefits (Heffner 2009). Thus, a relevant question for researchers and practitioners alike is *how* to achieve the benefits expected from adopting SOA.

While the potential benefits are well understood and include increasing IT infrastructure *flexibility* (e.g., Kumar et al. 2007; Yoon and Carter 2007) and services *reuse* to achieve cost decreases and increasing enterprise agility (e.g., Baskerville et al. 2005; Yoon and Carter 2007), extending a firm's IT governance to utilize SOA is not trivial. The SOA concept comprises the idea of a component-oriented coupling of business processes and their implementation using a new service layer (Siedersleben 2007). Hence, introducing SOA necessitates managing this new service layer between the existing business processes and application systems. SOA governance therefore requires finding ways to establish structures and processes and develop employees to handle the new relationship between IT and process architecture. Our research question thus is:

Which SOA governance mechanisms are important to implement an effective SOA that increases IT flexibility and leads to service reuse?

Our research model shows how SOA governance affects IT flexibility and reuse. An empirical evaluation based on data from 81 firms using SOA reveals the differential impact of various SOA governance mechanisms (structures, processes, and employees/relations). The study contributes (a) to existing research by offering the first empirically substantiated analysis of the importance of SOA governance and a comparison of the influence of different SOA governance mechanisms, and (b) to practitioners by providing evidence-based answers to the question, which governance mechanisms are most important for achieving IT flexibility and reuse.

We first delineate conceptual foundations regarding SOA – modular systems theory, IT flexibility, and SOA governance – and then develop the research model and hypotheses. Afterwards, we explain our approach and data before testing the model. Finally, results, limitations, and areas for future research are discussed.

2 Concepts and Related Research

This section first briefly discusses why, from a theoretical perspective, SOA needs governance to then draw on existing literature for developing the core concepts of our research model.

2.1 Conceptualization of SOA

SOA has attracted attention for its promise of new ways to cope with old IT architecture challenges. The literature, while focusing primarily on technical aspects, includes important research areas (Ren and Lyytinen 2008) such as security, reliability, service composition (Curbera et al. 2003), the selection and management of services (Yu et al. 2007), and orchestrating services (Peltz 2003). Some research also addresses the question of the benefits that result from SOA adoption (Joachim et al. 2011; Kumar et al. 2007).

Based on a review of the SOA literature, Joachim (2011) categorizes frequently mentioned characteristics of SOA as either technologies often used for implementing SOA, service-oriented design principles applied at the IS architecture level, or principles for establishing a service-oriented enterprise (SOE). However, beyond these common characteristics, "it seems that there is little agreement among practitioners and researchers alike as to a standard definition of SOA" (Erickson and Siau 2008, p. 43). Erickson and Siau identified nine different formal definitions of SOA, which range from "*modularizing a firm's business activities into functional services*" to "*using web services for distributed computing*". In our work, we draw on Bieberstein et al., who define SOA as a holistic concept comprising IT *and* business aspects: "A service-oriented architecture is a framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities" (2005a, p. 5).

Yoon and Carter (2007) investigate the benefits that drive an organization's interest in adopting SOA. Their case studies reveal that SOA can facilitate integration of systems, improve data flow and customer service as well as reduce IT cost. Also, SOA can lead to quicker IT responses to market change or customer demand and to reuse of already existing implemented functionality. Baskerville et al. (2005) emphasize the theoretically high potential of reuse in an SOA, even though they could only partly show positive effects of reuse (such as lower development costs or responding quicker to changing customer demands) in their two case studies, as existing services needed to be adapted to reuse existing functionality. Another benefit of SOA is a higher level of flexibility, as previously developed modular services can be reused or locally extended if business needs change or new needs arise (Yoon and Carter 2007). Gartner summarizes the role of achieving reuse in an SOA: "Reuse is not a benefit of SOA but a hurdle that needs to be overcome in order to improve business agility and lower software maintenance" (Saran 2006). This important role of reuse is supported further by Bieberstein et al. (2005b, pp. 692-693), who state that "reuse promotes company-wide consistency of key business operations and processes, while reducing costs."

Synthesizing prior efforts, Becker et al. (2009) did an extensive literature analysis and thus identified agility, and reuse as the most important benefits of SOA with which we concur. Thus, we will draw on those as our endogenous variables when developing our model.

2.2 Applying Modular Systems Theory to the SOA Paradigm

While modularity is a key concept in various scientific disciplines, such as biology, mathematics, and psychology, a thorough theoretical consideration of modularity as a key constituent in services metaphors in general, and for SOA in particular, is lacking. Schilling (2000, p. 312) defines: "Modularity is a general systems concept: it is a continuum describing the degree to which a system's components can be separated and recombined, and it refers both to the tightness of the coupling between components and the degree to which the 'rules' of the system architecture enable (or prohibit) the mixing and matching of components." Essentially, almost all biological, technical and other systems can be interpreted as hierarchically nested modular systems (Simon 1962) that "are intentionally designed to require low levels of coordination so that they can be carried out by an organizational structure of quasi-independent divisions functioning as loosely coupled subsystems" (Sanchez and Mahoney 1996, p. 64). In this vein, business processes and supporting applications can be modularized into services by adopting SOA (Papazoglou and Heuvel 2007). As is the case for each modular system, the components or services of an SOA represent other subsystems that can again be viewed as a modular system consisting of finer, loose services (Simon 1962). However, "loose does not mean lax; loosely coupled systems operate to very stringent performance requirements" (Hagel and Brown 2005, p. 85). For example, a modular, loosely coupled product design enables a decentralized production process in cases where well-defined standard interfaces exist. This allows employees to work on separate components while still ensuring that the resulting components can interact effectively (Schilling 2000). In the context of SOA, dedicated governance and management mechanisms define the necessary standards for locally developed, modularized services to facilitate the reuse of services in other processes. From a business-oriented perspective on services management, there is a substantial gap between, for example, SOA potential resulting from modularity, and realized SOA benefits resulting from reuse. SOA faces the challenge – and opportunity – that service construction needs to be directed towards business goals. SOA governance thus directs how services are constructed and how they are used and reused.

2.3 IT Flexibility

Achieving flexible IT is an important IT strategic goal (Kumar 2004) and a major reason to adopt SOA. Byrd and Turner (2000) have conceptualized the flexibility of IT infrastructure as the combination of both the human and technical IT infrastructure. Since our research addresses the SOA domain, which is mainly an architectural and technical concept, we restrict our research to the technical part of IT infrastructure flexibility, which we hereafter refer to simply as *IT flexibility*, defined as the "degree to which its [the IT infrastructure's] resources are sharable and reusable" (Duncan 1995, p. 42).

Based on the degree of shareability and reusability of the resources within an IT infrastructure, Duncan proposes three criteria for IT flexibility: (1) connectivity, that is, enabling components to connect to each other; (2) compatibility, that is, allowing connected components to interact and share information (Chung et al. 2003); and (3) *modularity*, that is, "isolating and standardizing as many business and systems processes as possible" (Duncan 1995, p. 48) and covering applications and data. Byrd and Turner define modularity as "the ability to add, modify, and remove any software, hardware, or data components of the infrastructure with ease and with no major overall effect" (2000, p. 171). However, an empirical evaluation of Duncan's three dimensions by Byrd and Turner found a lack of discriminant validity between connectivity and compatibility; therefore, they were merged to the new concept of *integration* (2000).

Chanopas et al. (2006) extended these works and identified another dimension, *scalability,* to be an important part of IT flexibility[46]. Scalability – "the degree to which hardware/software can be scaled and upgraded on existing infrastructure" (Chanopas et al. 2006, p. 645) – can be seen as an important outcome of SOA. SOA is generally expected to exhibit higher scalability than point-to-point connections because an enterprise service bus (ESB) is applied for application integration. This solves the major problem of rapidly increasing complexity with a rising number of systems to be integrated in case of point-to-point connections (Papazoglou and Heuvel 2007). A scalable IT infrastructure allows for easier handling of increasing numbers of users, workload or transaction volume (Chanopas et al. 2006; Kumar 2004). For example, in an SOA multiple instances of resource intensive services can be deployed across (e.g., virtualized) computing nodes and accessed using dynamic routing to avoid bottlenecks (resulting from increasing transaction volume) (Papazoglou and Heuvel 2007).

Based on those previous works, we conceptualize technical IT flexibility by the three dimensions of modularity, integration, and scalability.

2.4 SOA Governance

SOA governance is frequently proposed as the means to an effective SOA (Varadan et al. 2008; Walker 2007). The basic idea is that SOA governance should support the firm in handling any challenges arising from SOA implementation.

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[46] Actually, Chanopas et al. found five additional flexibility aspects: scalability (11), modernity (6), continuity (2), rapidity (2), and facility (1). The number of IT experts out of a total of 11 interviewees reporting the respective characteristic of IT infrastructure flexibility is given in parentheses. However, scalability showed to be the only one consistently reported by all 11 IT experts.

Research regarding SOA governance has focused mainly on developing methods for designing and implementing single services or entire service-oriented solutions (Arsanjani et al. 2008). Other works investigate selected SOA governance aspects, such as methods for: service identification of single services (Esswein et al. 2009); service integration testing (Bertolino and Polini 2009); describing models and tools for supporting SOA governance activities at the technical level (Derler and Weinreich 2007); developing an SOA governance approach based on the lifecycle of single services (Schepers et al. 2008); or proposing new organizational structures for SOA (Bieberstein et al. 2005b). There is also broader research that takes a more comprehensive approach to SOA governance. For example, Leusse et al. (2009) propose a special SOA governance model for handling nonfunctional requirements in a dynamic way. Strnadl (2007) formulates a specific semantic meta model that captures the combined requirements of business process management and SOA governance, while Niemann et al. (2008) suggest a generic SOA governance model emphasizing the control cycle and Varadan et al. (2008) develop an SOA governance framework based on IBM's client experiences.

Although many SOA governance and management mechanisms have been proposed in the academic and practitioner literature, to the best of our knowledge none of the concepts has been evaluated by quantitative studies to examine their contribution to a successful SOA implementation. To select the SOA governance mechanisms to be included in our study, we first selected two established governance models to identify important governance mechanism categories. The generic IT governance model of De Haes and Van Grembergen (2009) distinguishes between *structures*, *processes*, and *relational mechanisms*, while the conceptual SOA governance model suggested by Kohnke et al. (2008) draws on *structures*, *processes*, and *employees/relations*. As both models draw on three comparable pillars, we decided to focus on these three categories and harmonize the labels from both governance models.

In a second step, we conducted a review of the research literature on SOA (Joachim 2011), to identify different SOA governance mechanisms that have been proposed often for each of the three categories. We identified 33 papers[47] with statements regarding SOA governance. However, as very general propositions like "*SOA governance is important for an effective SOA*" do not mention particular SOA governance mechanisms, we excluded those papers that did not investigate SOA governance in detail. In total, we investigated 10 papers, each offering detailed insights into different SOA governance mechanisms. Table 1 lists the SOA governance mechanisms and shows the relative frequency they were mentioned in the investigated papers.

[47] These sources were selected based on the top 25 IS research journals according to the ranking by Lowry et al. (2004). In addition, the IBM Systems Journal was included, because it is listed as top global practitioner journal (Lowry et al. 2004) and covers a significant part of SOA research. Moreover, four IS conferences (ICIS, AMCIS, ECIS, and HICSS) were considered to cover more recent SOA research. Finally, the references of the identified articles were checked to identify further relevant articles in those and other outlets.

Governance category	SOA governance mechanism	Description	Source	Frequency (out of 10)
Structure	**New decision-making body**	Establishing a new, SOA-specific decision-making body (e.g., SOA Center of Excellence (CoE) or an SOA board) which has the decision rights regarding company-wide planning of all SOA-related tasks and is not limited only to making recommendations.	1, 2, 4-9	8
	Standards	Defining internal, SOA-related technology standards to which all projects must adhere.	1, 2, 4-9	8
	Roles & responsibilities	Establishing new roles (e.g., SOA leads, service owner) and supporting the collaboration and coordination of SOA activities when new services need to be developed or existing ones need to be adapted for reuse in another domain.	2-4, 8, 9	5
Processes	**Service management**	Implementing service management processes is important to support the service operation. Service management covers the entire service portfolio, which needs to be prioritized and coordinated during its lifecycle.	1, 2, 4-10	9
	Service development	Adhering to obligatory design guidelines to develop coherent services across the firm and reduce service redundancy.	1, 4-10	8
	Performance measurement	Using aligned metrics to monitor the services (should be jointly selected with the business units) to align the SOA implementation with business goals (e.g., higher flexibility, reduced business process costs).	2, 4-6, 8	5
Employees	**Qualifications**	SOA can be successful only when IT personnel understand service-oriented thinking and the SOA paradigm. If not available, appropriate trainings have to be established.	2-5, 7-10	8
	IT/business communication	For implementing effective services, good communication between IT and business units is important to facilitate knowledge exchange and thus align IT with business requirements.	1-5, 8-10	8
	Collaborative work of business units	SOA governance has to promote collaborative work of business units to support the identification of synergies and define requirements across different business processes.	2-4, 6-9	7
	Incentives	Using incentives (e.g., annual bonuses) to increase the commitment of the employees to the changes that result from implementing SOA (e.g., rewarding developers or business units for identify service reuse potentials).	2-4, 9, 10	5

1 Becker et al. (2009), 2 Bieberstein et al. (2005b), 3 Kavianpour (2007), 4 Kohnke et al. (2008), 5 Lee et al. (2010), 6 Schepers et al. (2008), 7 Tewary et al. (2009), 8 Varadan et al. (2008), 9 Walker (2007), 10 Yoon and Carter (2007)

Table 1. Frequently mentioned SOA governance mechanisms (bold = used in our study)

The model development, which follows in the next section, includes those governance mechanisms that were mentioned as being important by the majority of the papers.

3 Research Model

We next develop our research model (visualized in Figure 1), theorizing the influence of the three categories of SOA governance (i.e., structures, processes, and employees/relations) on (a) the three dimensions of technical IT flexibility (i.e., modularity, integration, and scalability) as identified in the previous literature, and (b) reuse to trace separately the effects of different SOA governance/management mechanisms in more detail.

3.1 Structures

Structures are the first of the three categories of SOA governance proposed by Kohnke et al (2008). Within this category, we look explicitly at two aspects (Table 1): establishing new decision-making bodies and using standards. One example of implementing such a new decision-making body for SOA governance could be the SOA Center of Excellence (CoE) (Walker 2007). However, it depends on whether the CoE is restricted to identifying problems and making recommendations or whether it also has authority to make decisions (Schepers et al. 2008). The CoE is a board or committee comprising business domain owners as well as IT and, in particular SOA experts (Keen et al. 2008). The CoE consolidates the SOA-related knowledge of the organization and performs the company-wide planning of all SOA-related tasks (Mitra 2005). While existing decision-making bodies can accomplish the first SOA pilot projects, specific decision-making bodies, such as a CoE or an SOA board, are usually implemented when SOA is adopted more broadly. For example, Walker describes how existing internal enterprise architecture governance mechanisms were leveraged to steer the SOA-related activities rather than "defining a completely new and independent governance structure" (2007, p. 660). However, for handling a firm-wide introduction of SOA, it is often suggested that a new governance body is put into place to achieve the desired goals, such as increasing flexibility and reuse (Varadan et al. 2008, p. 480).

Hypothesis (H1a): Introducing a new decision-making body (e.g., SOA Center of Excellence) increases IT flexibility in terms of modularity, integration, and scalability.

Hypothesis (H1b): Introducing a new decision-making body (e.g., SOA Center of Excellence) increases reuse.

Establishing and using standards is a further SOA governance mechanism beyond establishing new decision-making bodies. Such standards range from criteria to guide whether functionality should be implemented as services (e.g., expected frequency of service use) through to design standards for system interfaces (Bieberstein et al. 2005b; Lee et al. 2010). The former can help to identify the appropriate level of modularity and granularity of services, which facilitates reuse, while the latter can enhance flexibility to integrate functionality freely as needed or replace existing functionality with a new service, or if decisions are based on open reference models (Bieberstein et al. 2005b).

Hypothesis (H2a): Applying common standards increases IT flexibility in terms of modularity, integration, and scalability.

Hypothesis (H2b): Applying common standards increases reuse.

3.2 Processes

In the SOA governance *processes* category, we distinguish between processes that support service management and those related to service development. Service management processes provide a centralized overview of existing services and their control during the entire service lifecycle (Walker 2007). Moreover, good service management includes policies and agreements for charging service use. This allows for compensation to the business units which first demands a service and then bears the additional costs required to develop a generic service that is reusable by other business units, as opposed to implementation of a service specific to the needs of a single business unit, which would cost less (Walker 2007). Tasks related to managing the availability of services, application management, and service support are also part of the service management process (Kohnke et al. 2008; Schepers et al. 2008). In addition, Varadan states that "the realization of SLAs between providers and consumers" is important (2008, p. 481). A central perspective on all existing services guides the development of new services and the adaptation of existing services to create a flexible IT infrastructure. Thus, it allows for increased reuse of existing services.

Hypothesis (H3a): Implementing service management processes increases IT flexibility in terms of modularity, integration, and scalability.

Hypothesis (H3b): Implementing service management processes increases reuse.

Analysis of existing services can raise the need to refine existing services or to develop new ones. To ensure that newer versions of existing services or new services are still compatible with other existing services, clear service development processes are needed. This ensures further that services are designed to be sufficiently modular to support their flexible integration and later reuse (Lee et al. 2010). Service development processes should also ensure that, whenever possible, existing functionality is reused and not developed anew. The development of reusable services is seen as considerable effort (Becker et al. 2009) that needs additional guidance by established processes. As services should not be defined separately for each project, there is a need "to evangelize solutions across projects and processes" (Hirschheim et al. 2010, p. 44).

Hypothesis (H4a): Establishing service development processes increases IT flexibility in terms of modularity, integration, and scalability.

Hypothesis (H4b): Establishing service development processes increases reuse.

3.3 Employees/Relations

The third and final category of SOA governance mechanisms comprises actions related to the involved *employees/relations*. We distinguish between the qualifications of involved IT employees, IT/business communication, and the collaborative work of different business units when developing services. The existing knowledge and skills of employees regarding the implementation and management of SOA are important. SOA also require new skills that, in turn, may require training (Kohnke et al. 2008). Thus, organizations often educate their employees with respect to building, reusing, and deploying services (Yoon and Carter 2007). Further, "new skills in technology, architecture, development, and infrastructure design" are often required to implement an ESB and registry (Varadan et al. 2008). Without sufficient knowledge regarding SOA and the concept of service orientation, it is unlikely that services will be designed in such a way that they create the expected flexible IT infrastructure or are sufficiently modular to be reused.

Hypothesis (H5a): Better SOA-qualified employees will allow for higher IT flexibility in terms of modularity, integration, and scalability.

Hypothesis (H5b): Better SOA-qualified employees will allow for higher reuse.

Tiwana et al. (2003) already revealed that better knowledge exchange between business and IT increases flexibility in IT projects. Correspondingly, Sabherwal and Chan found that better

IT/business alignment increases (business and IT) flexibility (2001). According to Chen (2008), alignment via communication is one of three important means to achieve IT/business alignment, in addition to alignment via architecture and governance in an SOA. Chen highlights further that, in particular, "efforts are made to narrow 'culture gaps' between business and IT people, which has been a major cause for system development failure" (2008, p. 3). Consequently, when there is good communication between IT and business employees, the resulting SOA is more likely to fulfill business demands regarding flexibility and reuse, because there will be fewer problems and misunderstandings.

Hypothesis (H6a): Good communication between IT and business units increases IT flexibility in terms of modularity, integration, and scalability.

Hypothesis (H6b): Good communication between IT and business units increases reuse.

As services in an SOA should support business needs (Bieberstein et al. 2005a), it is important that the business units work collaboratively on the specifications of services and that they are able to communicate their specific needs (Yoon and Carter 2007). Krafzig et al. (2005) highlight that "being able to talk about the specific nature of different services at an abstract level will enable the different stakeholders in an SOA project [...] to communicate their ideas and concerns more effectively." Therefore, a common understanding of services and communication among business units to identify synergies between business processes is important to promote an effective IT infrastructure that should not only serve the minority of single business units appropriately but also fulfill the needs of the majority. Thus, SOA governance should create "an effective collaboration environment across multiple business units with a diverse set of business goals" (Walker 2007, p. 652) to deploy "shareable and reusable services such that they can be used across lines of business and across processes in a manner dictated by the business" (Varadan et al. 2008, p. 473).

Hypothesis (H7a): The collaborative work of different business units increases IT flexibility in terms of modularity, integration, and scalability.

Hypothesis (H7b): The collaborative work of different business units increases reuse.

3.4 Modularity as Mediator

While integration and scalability, as part of IT infrastructure flexibility, provide benefits for the adopting organization, modularity as a third aspect of IT flexibility does not per se constitute any value for the organization. The reasoning behind modularity is that the functionality encapsulated in the service can be reused in other business activities (Yoon and Carter 2007). Thus, functionality is not encapsulated as modular services for its own sake, but is worth the additional effort only if the services are actually reused. According to modular systems theory, services that are modular and loosely coupled can be separated and recombined easily, enabling different combinations and reuse of services (Schilling 2000).

Hypothesis (H8): A higher degree of modularity will increase the reuse of services in an SOA.

The higher the degree of modularity, the more likely a service can be reused in another context (Baskerville et al. 2005). Yet, managerial complexity and communication overhead increase when the same functionality is split into loosely coupled services rather than implementing it into just one tightly coupled, aggregated service. A service with a rather low degree of modularity, though, is hardly reusable in other contexts, as it is tightly coupled with other services and difficult to separate from its context. This makes the use of just one part or the entire service in other contexts difficult or even impossible. Thus, modularity is expected to be a key enabler of reusing functionality. We therefore propose that SOA governance and management mechanisms not only directly increase reuse, but are (partially) mediated by modularity as key facilitator of reuse.

Hypothesis (H9): Modularity mediates the influence of SOA governance/management mechanisms on reuse of functionality.

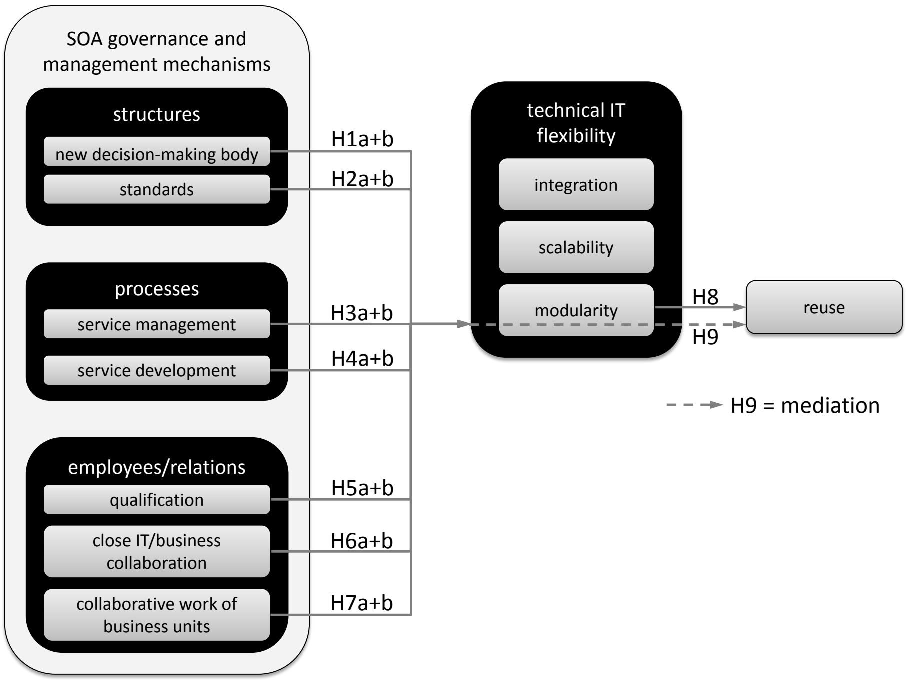

Figure 1. Research model

4 Methodology and Analysis

This section begins by explaining the data collection and methodology, followed by a test of the data quality as well as of the validity and reliability of the measurement model. Finally, the research model is evaluated.

4.1 Approach

Data Collection: We applied a quantitative approach and conducted a survey in the German service industry, comprising logistics, trade, financial services, energy, and so on (US SIC codes 4,000 to 8,999). We chose the service industry because of its comparatively higher reliance of its business processes on IT compared to other industries in which the role and importance of physical assets and materials may be significant contingencies.

We contacted the firms individually by phone to identify the manager in charge of the IT architecture and to request participation in the survey. This led to appropriate persons being identified in 1,743 firms. Next, we mailed out a paper-based questionnaire. After two reminders (via postal mail and phone), we eventually received 247 questionnaires (i.e., a response rate of 14.2%). To test our hypotheses, we selected only those responding organizations that had already adopted SOA and show a sufficient degree of SOA supporting their business processes to offer valid insights into SOA governance/management mechanisms. Thus, we eliminated 124 of the 247 responding organizations that had not yet adopted SOA.

Measurement: All but one construct are based on (reflective) multi-item measures and were derived from the literature where possible (i.e., in the case of modularity, integration, and scalability); these are shown in Appendix A. Establishing a "new decision-making body" was the only construct operationalized by a single item, as it does not comprise or is formed by two or more components (Bergkvist and Rossiter 2007)[48]. We used a single item that asked for rating the degree to which new decision-making bodies have been established for SOA directly. The other constructs measuring the SOA governance mechanisms were newly developed for this study, as we are not aware of a prior quantitative study that has investigated SOA governance/management mechanisms.

Before designing the survey, we reviewed the literature on SOA governance and conducted a series of case studies in 9 large German services firms. One part of the case study interviews examined the SOA governance/management mechanisms applied in the particular firm. Thus, we had the opportunity to learn SOA lingo from experts, receive feedback about our model and items, and gain insights into different SOA governance approaches and their importance for effective SOA implementation.

Next, we discussed the operationalizations of the new constructs with a group of seven researchers experienced in the field of SOA to avoid unclear or ambiguous formulations. Moreover, we asked an industry expert panel consisting of consultants active in the SOA domain to assess the items and their content. We followed their suggestions and refined our measurement instruments accordingly. As no additional items were proposed, their responses also suggested that our items adequately cover the content domain (Lewis et al. 1995).

Then, we evaluated content validity involving ten consultants from several consulting firms and experienced in SOA following the procedure applied by Lewis et al. (1995). This approach requests each panelist to rate the relevance of each item on a three-point scale in order to calculate the content validity ratio (CVR). All except two items showed a CVR equal to or higher than .80 and thus fulfill the requested threshold of .62 (Lawshe 1975) meaning that the overwhelming majority of panelists feel that the developed items are important for SOA governance, which is significant at the five percent level. The two remaining items are rated at .60 (IBC2) and .40 (SMM2), thus, IBC2 is only marginally below the threshold. Using card sorting (Moore and Benbasat 1991), both items were consistently assigned to their intended constructs (IBC2 in 90% of the cases to IT/business communication and SMM2 in 80% of the cases to service management) by the same ten consultants. Assessing Fleiss' Kappa[49], the ten panelists showed a high inter-rater reliability of .76. As both items are part of reflective multi-item measurement models each consisting of three

[48] Using single-item measurement models is accepted in IS research, particularly in the early phases of measures developments, as in our case. For example, Sedera and Gable (2010) assessed knowledge transfer and knowledge application, or Klein and Rai (2009) assessed buyer dependence on supplier using a single item.

[49] Interpreting Fleiss' Kappa is similar to Cohen's Kappa; the difference is that it relieves the assumption of having only two coders allowing us to compute the inter-rater reliability for more than two coders (Petter et al. 2007). For example, Moore and Benbasat (1991) report that scores above .65 are acceptable for Cohen's Kappa, and Petter et al. report values above .76 to represent "high level of agreement between the coders".

items and as reflective constructs are in general more robust than formative constructs (Petter et al. 2007), we decided to keep these two items within the model.

As control variables we added organizational size (measured by total number of employees from secondary data sources), industry type (dummy variables for logistics&trade, financial services, and ICT), and usage of general IT governance mechanisms (ITIL and COBIT). Including the latter in the analysis allows for examining whether IT flexibility is predicted by the investigated SOA governance mechanisms or rather by the use of ITIL or COBIT, which are not SOA-specific.

Analysis: We used Partial Least Squares (PLS) (SmartPLS, Ringle et al. 2007) and SPSS to analyze the data. For testing the hypotheses, we implemented two different models:

- *flexibility model*: First, we tested the hypotheses between the different SOA governance/management mechanisms and technical IT flexibility (consisting of modularity, integration, and scalability).
- *direct and full reuse model*: Second, we estimated a pair of models comprising the influence of the different SOA governance/management mechanisms on reuse as well as the mediating role of modularity. The *direct reuse model* links the different SOA governance/management mechanisms to reuse while the *full reuse model* adds modularity as mediator in between. Comparing the results of both models allows for testing the mediation effect.

Analyzing the results from the flexibility and reuse models allows for an integrated picture of the effects of SOA governance/management mechanisms on IT flexibility as well as on reuse.

Our data set comprised several missing values. Since SOA adoption is infrequent and since the usable data set is comparably small, we followed the suggestions of Kristensen and Eskildsen (2010) to apply missing value treatment. Kristensen and Eskildsen simulated the effects of applying different missing value handling strategies and found that replacing the missing values using the expectation-maximization (EM) algorithm leads to more valid and more reliable estimation results, compared to pairwise deletion or simple treatments such as mean value substitution. However, we applied a very conservative approach and used the EM algorithm only for those items, which had at most 3 missing responses (i.e., 3.7% missing values at most) while eliminating data from the other questionnaires from the data set. This led eventually to 81 responses used in the following calculations.

4.2 Quality of Data and Measurement Model

Before evaluating our research model, we tested our data for *normality* using the Kolmogorov-Smirnov test and assessed skewness and kurtosis, which showed that some of our items are not normally distributed. This and the limited sample size were the reasons why we chose PLS instead of covariance-based SEM for testing our research model.

Further, we examined the data regarding *non-response bias*. Therefore, we compared the answers given by the early respondents to those respondents who answered only after several reminders. The basic assumption of this approach is that the latter group shares similarities with those receivers of the questionnaire that have not answered at all, and thus can serve as a proxy, as argued in Armstrong and Overton (1977). As no indicator showed a significant difference according to the Kolmogorov-Smirnov test, we can assume that non-response bias is not a major problem in our data. Similarly, no differences were shown in the answers not included in the analysis because of missing values in single items.

Next, we took several measures for making sure that *common method bias* had not affected our results, such as using different questionnaire versions and applying the marker variables approach. The details are reported in Appendix D.

After analyzing the quality of our data, we tested the *reliability* and *validity* of the PLS measurement model. All but one indicator loading (SMM3 .699) where above .707 (cf. Appendix A). Appendix B shows that construct reliability, convergent and discriminant validity are satisfied in both model estimations, too[50].

4.3 Analyzing the Influence of SOA Governance on IT Flexibility (Flexibility Model)

Table 2 shows the path coefficients from testing the *flexibility model* (paths from all governance constructs to the three IT flexibility dimensions). Notably, establishing new decision-making bodies has a significantly negative relationship with modularity and integration but no influence on scalability. Standards show strong relationships with all three dimensions of technical IT infrastructure flexibility. Further, service management processes have a weakly significant influence on modularity and integration but none on scalability. With respect to employees/relations, the results show that their qualifications as well as IT/business communication positively affect all three dimensions of IT flexibility. Finally, the service development process and the collaboration of different business units are only related to modularity. The remainder of the hypothesized relationships are not significant. Also, COBIT shows no significant influence while ITIL contributes weakly to integration.[51]

[50] Construct reliability is ensured because in any case the composite reliability (C.R.) is larger than .7 as requested by Nunnally (1978), and, as Chin (1998) demands, the average variance extracted (AVE) is larger than .5 for all constructs, showing convergent validity. Discriminant validity is given in our models as the square root of the AVE of all constructs is higher than their respective inter-construct correlation (Gefen et al. 2000). We also checked the cross loadings of the indicators and confirmed that all indicator loadings are highest to their own constructs and lower to all other constructs (cf. Appendix C).

[51] To satisfy the recommended sample size requirement by Chin (1998) (i.e., 10 times the number of incoming links of a single construct), the results shown in the tables are based on PLS tests without the control variables. In addition, we tested each of the four control variables in separate PLS models as Liang et al. (2007) did, which did not reveal major differences in the path coefficients of the investigated relationships. Under the given sample size restrictions, this represents the most conservative approach.

Impact of SOA governance mechanism…			*on…*		
	Hyp.	Mechanism	Modularity	Integration	Scalability
Structures	H1a	New decision-making body	**-.256***	**-.339****	-.008
	H2a	Standards	**.334****	**.307****	**.246***
Processes	H3a	Service management	**.156**$^{+}$	**.162**$^{+}$	-.059
	H4a	Service development	**.138**$^{+}$	.102	-.092
Employees/ relations	H5a	Qualification	**.135**$^{+}$	**.216***	**.223***
	H6a	IT/business communication	**.159***	**.147**$^{+}$	**.261***
	H7a	Collaborative work of business units	**.214***	.094	-.062
Controls		Organizational size	**-.207***	**-.224***	-.017
		ITIL	.105	**.133**$^{+}$	.014
		COBIT	-.069	.069	.013
		Industry type:			
		Logistics & trade	**.127**$^{+}$	-.108	.016
		Financial services	.053	**.091**$^{+}$	**.106**$^{+}$
		IT & communication	**-.238****	-.013	-.035
**: $p \leq .01$; *: $p \leq .05$; $^{+}$: $p \leq .1$[52]					

Table 2. Flexibility model test results (β and significance levels)

Table 3 presents the R^2 of the dependent variables (modularity, integration, and scalability). The different SOA governance/management mechanisms predict a significant part of the variance in modularity (45.8%) and integration (37.8%), while the explanation of scalability (18.3%) is weak.

R-squares	Modularity	Integration	Scalability
Flexibility model	.458	.378	.183
Controls only	.218	.114	.023

Table 3. R-squares (flexibility model)

Correspondingly, Table 4 provides the single effect sizes (f^2). We find that, according to Chin (1998), all SOA governance mechanisms have small to medium effects on modularity and that all except service development processes and the collaborative work of business units also have a similar effect on integration. However, only standards, the qualification of employees, and IT/business communication have a small effect on scalability.

		Effect size of SOA governance mechanism on…		
SOA governance mechanism		Modularity	Integration	Scalability
Structures	New decision-making body	**.06**^{b}	**.10**^{b}	.00
	Standards	**.19**^{a}	**.14**^{a}	**.06**^{b}
Processes	Service management	**.02**^{b}	**.02**^{b}	.00
	Service development	**.02**^{b}	.01	.01
Employees /Relations	Qualification	**.03**^{b}	**.06**^{b}	**.05**^{b}
	IT/business communication	**.03**^{b}	**.02**^{b}	**.05**^{b}
	Collaborative work of business units	**.06**^{b}	.01	.00

Table 4. Single effect sizes (f^2) (^{a}: medium; ^{b}: small)

52 Because of the small sample size we chose to also consider $p \leq .1$ as threshold for (weakly) significant relationships as it is done in other studies using SEM (Worren et al. 2002; Zhu and Kraemer 2002). In this way, we can avoid severe type-II-errors which might just arise from the small sample. However, relationships that do not meet the traditional .05 significance level but only the .1 level, will be particularly carefully discussed.

4.4 Analyzing the Mediation Effects between SOA Governance, Modularity, and Reuse (Reuse Model*)*

Table 5 presents the results of testing the *reuse model* with and without modularity (i.e., *full vs. direct reuse model*); comparing the results uncovers the mediation effect of modularity (Baron and Kenny 1986). First, the results exhibit clearly that modularity is positively related with reuse of functionality (cf. Table 5, full reuse model). Further, analogous to the flexibility model estimation, establishing new decision-making bodies for SOA governance is negatively related with reuse. Using standards enhances reuse, and having clear service management processes seems by far to be the single most important SOA governance factor for driving reuse. By contrast, it is interesting that implementing service development processes, better IT/business communication, and collaboration among business units show no positive relationship with reuse. The collaboration of different business units seems to even dampen the effect of modularity on reuse (no relationship in the direct reuse model, but a significant negative relationship in the full reuse model). The negative relationship is caused by a statistical suppressor effect; it can be interpreted such that collaboration of business units increases modularity but not reuse. In addition, the direct reuse model without modularity as mediator, shows that better qualification of employees with SOA skills does indeed increase reuse.

The R^2 show that the SOA governance/management mechanisms account for 48.7 percent of the variance of reuse, while the controls alone account for only 6 percent of reuse. Thus, SOA governance is an important determinant for the degree of reuse in an SOA.

Looking at the single effect sizes (f^2) clarifies that reuse is predicted largely by modularity and it also demonstrates the importance of service management processes for facilitating reuse.

Hyp.		Determinant	Direct reuse model (without modularity)		Full reuse model (with modularity)		Mediation analysis (for full reuse model)		
			Path (β) on reuse	Single effect (f^2) on reuse	Path (β) on reuse	Single effect (f^2) on reuse	Lower bound	Upper bound	Point estimate
H8		Modularity	*n/a*	*n/a*	**.459****	**.22**^{a}			
Structures	H1b	New decision-making body	**-.380****	**.13**^{b}	**-.268****	**.12**^{b}	**-.338****	**-.004****	-.126
	H2b	Standards	**.271****	**.11**^{b}	**.113**$^{+}$	**.02**^{b}	**.017****	**.355****	.163
Processes	H3b	Service management	**.482****	**.20**^{a}	**.423****	**.17**^{a}	**.004***	**.209***	.080
	H4b	Service development	.119	.01	.064	.00	**.003***	**.189***	.072
Employees/ relations	H5b	Qualification	**.152***	**.03**^{b}	.086	.01	**.005***	**.178***	.070
	H6b	IT/business communication	.010	.00	-.083	.01	**.004***	**.186***	.074
	H7b	Collaborative work of business units	-.031	.00	**-.125**$^{+}$	**.02**^{b}	**.007***	**.227***	.096
Controls		Organizational size	**-.190***		-.093				
		ITIL	-.063		**-.118**$^{+}$				
		COBIT	-.001		.030				
		Industry type:							
		Logistics & trade	-.078		**-.136**$^{+}$				
		Financial services	.105		.080				
		IT & communication	-.018		**.093**$^{+}$				
Note: significance levels of β: **: $p \leq .01$; *: $p \leq .05$; $^{+}$: $p \leq .1$; classification of effect sizes (f^2): ^{a}: medium; ^{b}: small									

Table 5. Influence of SOA governance mechanisms on reuse (β and f²)

Hypothesis 9 proposes that modularity mediates the influence of SOA governance/management mechanisms on reuse of functionality. First evidence is provided by the fact that the inclusion of modularity as a mediator goes hand in hand with most of the path coefficients (from SOA governance/management mechanisms to reuse) becoming weaker(Baron and Kenny 1986)such as for new decision making body, standards, qualification of employees, or, less strongly, for service management (cf. Table 5, comparing paths of direct with full reuse model). To test for the existence of partial or even full mediation effects, we re-estimated the direct reuse model using the approach suggested by Preacher and Hayes (2004), which was also adopted in other recent IS studies (e.g., by Coltman et al. (2011) and Al-Natour et al. (2011)). Following this procedure, we bootstrapped the sampling distributions using 2,000 bootstrap samples. The right columns of Table 5 show the point estimates as well as the lower and upper bounds of the 95 percent or 99 percent confidence intervals belonging to the mediation effect of modularity on the relationship between the different governance mechanisms and reuse. The results show that all mediation tests are statistically significant. However, according to Baron and Kenny (1986) a mediation effect requires that there is a significant direct relationship between the exogenous variable and the endogenous variable if the mediator is absent. By contrast, Shrout und Bolger (2002) argue that this requirement is not a necessity in the presence of rather low statistical power, which is likely in case of smaller sample size. According to these arguments, the statistically significant mediation effect of service development is likely to be an actual mediation effect, while in case of IT/business communication and collaborative work of business units we should not argue mediation to be existent since the basic relationship between them and reuse in the direct model is very close to zero.

Thus, we can summarize that all statistically significant relationships between governance mechanisms and reuse are partly mediated by modularity and that the strongest and most significant mediation effect can be identified for standards.

Table 6 summarizes all empirical results with respect to the importance of the different SOA governance/management mechanisms.

Corresponding model:		Flexibility model			Direct reuse model	Full vs. direct reuse model	
SOA governance mechanism:		**Influence on modularity**	**Influence on integration**	**Influence on scalability**	**Influence on reuse (H1-7b)**	**Mediation by modularity (H9)**	**Test of Hypotheses (H1-H7)**
Structures	**New decision-making body**	-	-		-		H1a+b rejected
	Standards	++	++	+	+	✓	H2a+b confirmed
Processes	**Service management**	+	+		++	✓	H3a largely confirmed H3b confirmed
	Service development	+				(✓)[53]	H4a+b rejected
Employees/ relations	**Qualification**	+	+	+	+	✓	H5a+b confirmed
	IT/business communication	+	+	+			H6a confirmed H6b rejected
	Collaborative work of business units	+					H7a+b rejected
Influence of modularity on reuse:					++ (H8 confirmed)		
Modularity acts as mediator:					H9 confirmed (for those governance mechanisms positively related with reuse)		

Note: shaded cells represent confirmed propositions; ++: significant positive relationship with medium effect size; +: significant positive relationship with small effect size; --: significant negative relationship with medium effect size; -: significant negative relationship with small effect size; ✓: significant mediation;

Table 6. Summary of all results (shaded cells represent confirmed propositions)

5 Discussion of Results, Implications, and Limitations

While previous research proposes that SOA governance in general is important, our results (Table 6) offer the first empirically substantiated analysis of the importance of SOA governance and a

[53] Mediation test according to Preacher and Hayes (2004) was confirmed. However, the direct path from service development on reuse in the direct model was not significant (probably due to low statistical power), which violates the condition of Baron and Kenny (1986). If we assumed the path being existent despite missing significance, this relationship between service development and reuse would be mediated by modularity.

comparison of the influence of different SOA governance mechanisms. Compared to previous conceptual works, our empirical results draw a more differentiated picture that highlights the importance of organizational aspects in addition to the well-known architectural ones. Also, our results open opportunities for discussing new insights into the differential importance and effects of SOA governance mechanisms for achieving SOA's benefits based on evidence.

Implementing new, dedicated decision-making bodies for SOA *hampers* organizations in achieving higher degrees of IT flexibility and reuse: One explanation for this contradictory result is that often existing IT governance decision-making bodies that have already existed before are also used for governing SOA (Walker 2007). Thus, this result first supports the argument that establishing new decision-making bodies specifically for SOA is not a necessity in earlier phases of SOA implementations (Kohnke et al. 2008). An additional post-hoc analysis comparing early (beginning of SOA implementation) and experienced (five or more years SOA) users[54] shows no significant difference in the distribution of implemented decision-making bodies[55]. This shows that both groups (firms experienced with SOA and SOA novices) alike often limit the degree of implementing new decision-making bodies but continue to use existing ones. We have seen similar phenomena in our nine case studies. For example, one of the studied firms defined its SOA governance as a "lean approach." Rather than implementing new decision-making bodies, the organization has relied completely on existing structures that are known to perform well. The interviewees argued that new decision-making bodies would require considerable efforts without providing better results in terms of IT flexibility and reuse. Thus, using the existing structures might be at least more efficient – if not effective – for achieving the desired goals.

Moreover, the negative statistical relationship implies that adding more governance might even reduce reuse effectiveness. Firms might implement new decision-making bodies for SOA in addition to the already existing IT governance mechanisms giving both the decision rights to jointly govern the SOA activities. This increases the complexity of decision making processes as coordination among more governance units requires more effort, takes longer and eventually hampers IT flexibility and reuse – this was a negative phenomenon that we could observe when studying the SOA undertakings at a large Swiss bank. As an additional effect, departments might start to work around *over-governed* SOAs and try to hide their local SOA initiatives to avoid the involvement of unwanted additional and centralized decision-making bodies that (from the department's perspective) simply add delays and confusion without contributing anything positive. Obviously, this work-around behavior strongly reduces the opportunity to gain synergies and to reuse already developed services. Future research should investigate different ways of implementing SOA-related decision-making bodies. Such analyses should scrutinize different scopes and degrees of power or rights associated with these decision-making bodies to reveal which structures are useful for which purposes and why, as well as which tradeoffs may arise. Altogether, establishing new decision-making bodies such as SOA centers of excellence turns out to be of no utility. Rather, a

[54] We split the data set of the 81 organizations into one group containing those 38 organizations that have adopted SOA for at most 2 years, and those 22 organizations that have adopted SOA for at least 5 years. We used t-tests to compare whether the means of the latent variable scores of the two groups are significantly different.

[55] In both groups, about 90 percent of respondents rated implementation of new decision-making-bodies for SOA (cf. DMB1 in Appendix A) between 1 and 3 on a 5-step Likert scale. Only 7.9 percent of the first group and 13.6 percent of the second group rated the item with higher than 3.

successful SOA introduction relies more on the efficient use of any functioning decision-making body that may already have existed before SOA. As a consequence, the success factor of *establishing new roles and organizational structures* often mentioned in expert interviews shows, in fact, to hamper IT flexibility and service reuse.

Comparing the effects of SOA governance on the different dimensions of IT flexibility shows that scalability is less affected than modularity or integration: Only three of the investigated SOA governance mechanisms (usage of standards, employee qualifications, and better IT/business communication) are positively related with s*calability*. As argued earlier, increasing scalability by adopting SOA is realized mainly on the technical layer and less from using SOA governance processes. For example, in an SOA multiple instances of resource intensive services can be deployed across (e.g., virtualized) computing nodes and are accessed using dynamic routing to avoid bottlenecks (resulting from increasing transaction volume) (Papazoglou and Heuvel 2007). Thus, most of the investigated SOA governance processes are too far away from actually influencing scalability, which is achieved on the technical layer. However, using standards is, of course, still beneficial as this mechanism addresses the technical layer. In addition, better communication between IT and business helps to identify the possible areas of services where scalability is needed and consequently allows implementing the services accordingly at the technical layer.

Besides the three mechanisms that are important for scalability, the *integration* facet of flexibility is supported by a fourth one: establishing service management processes. These processes support organizations in maintaining a consistent overview about the services and service versions deployed and used. However, the single most important SOA governance mechanism for facilitating integration is the consistent use of standards, which ensures efficient integration of different services even in the long term.

In comparison to scalability and integration, *modularity* is enhanced by all SOA governance mechanisms except implementing new decision-making bodies. This is not surprising as modularity is one of SOA's core aspects and therefore everything is directed towards enhancing modularity.

Reuse is only driven by using standards, service management processes and qualifications: While modularity *per se* is not beneficial but is driven by nearly all SOA governance mechanisms, reuse – as one of the core benefits of modularity – is only supported by standards, service management processes, and high employee qualification. Organizations face two problems when trying to reuse services. First, developing services for reuse increases development time (Schelp and Aier 2009). Second, in the majority of cases the developed services still have to be adapted to specific needs when reused (Baskerville et al. 2005). To overcome these problems organizations need to establish organization-wide standards which allow easier reuse of developed services and train employees to increase their qualifications. Also, employees need to be trained on how to reuse services (Yoon and Carter 2007). In addition, service management processes allow for a central overview about the existing services and increase the chance of identifying suitable existing services when needed by the business. Technically this can be supported by organization-wide registries and/or repositories (Yoon and Carter 2007).

According to our hypotheses, service development processes, collaborative work of different business units as well as IT/business communication should also be important factors for achieving reuse of the same functionality across multiple business units and processes. However, in our data this is not the case. Even though the establishment of service development processes is a necessary precondition for developing *potentially* reusable services, there is still a missing link to *actual* reuse.

Facilitating conditions to increase the reuse of services could be the collaborative work of different business units or IT/business communication. But, fostering collaborative work between business units can also have a downside. Increased collaboration will also raise complexity and thus make it more difficult to reuse services without the additional support of adequate processes. Even though clear development processes are in place, it could be that the processes are valid only for specific departments and are not overarching for the entire enterprise. Consequently, services are developed only for each project, which cannot lead to reuse without further solutions across the projects (Hirschheim et al. 2010). This argument is supported by the current state of most SOA implementations in action nowadays, since in most firms SOA is implemented not across the entire organization but only in specific areas. In our survey and in our case studies, the majority of participants stated that SOA is used primarily in single business areas. For example, in financial service companies, one often observes that the starting point for using SOA is in multi-channel customer interaction. Thus, reuse of existing services takes place between the different channels, but is limited to the particular business domain of retail banking and does not spill over to the rest of the bank. Thus, even though services could theoretically be reused in other areas of the organization, a wider reuse across different business units cannot take place at this particular stage of SOA implementation in practice (Schelp and Aier 2009). Accordingly, better communication between IT and business or between multiple business units at this limited state of SOA adoption does not increase the reuse of services.

Using standards, establishing service management processes, increasing qualifications of employees, and facilitating IT/business communication show to be the most important SOA governance mechanisms: Overall, our results show that of the seven investigated SOA governance mechanisms these four are the ones that are consistently positively related with the flexibility dimensions and reuse (significant relationships with at least three of the four outcome variables). The importance of these four mechanisms might be rooted in their role as forming a solid base for the remaining (and maybe later implemented) mechanisms. Particularly, highly qualified employees and organization-wide standards will also play important roles for other governance processes and for effective collaboration. Thus, these two build the foundation to develop a flexible IT as well as reusable services. Based on the foundation sown through the two previously mentioned governance mechanisms, service management processes are of particular importance to actually reuse the potentially reusable services and thus to leverage the theoretical potential of service orientation. Better IT/business communication will then guide how an organization's SOA will further develop in the future according to business needs, e.g., in terms of where integration and scalability are actually needed and where not. Thus, organizations should put strong emphasis on implementing these four mechanisms that in turn will support the entire SOA development process as they contribute to overall SOA implementation in terms of IT flexibility and reuse.

Our research has some limitations. First, the results regarding the effectiveness of SOA governance mechanisms for increasing reuse might be affected by the circumstance that the current state of SOA adoption is, in most firms, limited to a few business areas; thus, the often high potential of reusing services across the entire organization today is limited by the current state of low adoption in practice. Second, the tests performed to assess CMB (cf. Appendix D) indicate that the evaluation of our hypotheses may be conservative and – in combination with our comparably small data set – could have led to type-II-errors. Thus, "weakly confirmed" hypotheses, such as the relationship between service management and integration, may show to be significant in future studies. Third, for interpreting the importance of the different SOA governance mechanisms, one should keep in mind that we limited our research to the role of those mechanisms for achieving technical IT infrastructure flexibility and reuse. Thus, the importance of the investigated SOA governance/management mechanisms may vary for other benefits associated with SOA, such as increasing data quality or process quality or facilitating outsourcing opportunities (Beimborn et al. 2012). Fourth, most SOA governance mechanisms had only been implemented to a low to moderate degree in the surveyed firms. In some years, a repetition of the study may show more and stronger effects on IT flexibility. Finally, the existing literature on SOA governance/management mechanisms has largely neglected theory building. Thus, we were unable to apply a well-established theoretical foundation for our research model that would allow us to extend existing theory. However, by connecting the concepts of IT governance and IT flexibility, our work contributes to developing an IS servitization theory.

6 Conclusion

Overall, we can summarize that the majority of the investigated SOA governance/management mechanisms are confirmed to be relevant determinants for achieving IT flexibility from SOA. The most important SOA governance mechanisms are: using standards, establishing clear service management processes, increasing the qualification of employees, and facilitating IT/business communication. Our results offer a number of useful insights to services science and particularly services governance from an IS perspective. As this, to the best of our knowledge, is the first quantitative evaluation of SOA governance/management mechanisms, our results offer an evidence-based contribution to the discussion of the role of SOA governance when bringing together managerial and technical perspectives regarding service orientation. These can help future research advance the theoretical and business foundations of the SOA concept and disclose relations between technical and organizational goals and how both can be achieved. Particularly, when studying the business value impact of SOA, governance mechanisms are important organizational complements to be considered.

For managers, the results are helpful in implementing and developing SOA. Some 88 percent of our survey participants see the implementation of SOA as a challenging task, and almost as many expect organizational and governance changes to be necessary. As we have modeled both SOA governance and IT flexibility in a multifaceted way, the analyses reveal the differential influence of SOA governance/management mechanisms on IT flexibility dimensions and reuse. Organizations striving for higher IT flexibility or reuse as a substantial goal of an SOA initiative can use the results to single out the most relevant management mechanisms.

We can conclude that SOA governance is crucial to reap the fruits sown through service orientation. Our analyses have shown the importance of SOA governance for SOA's ability to improve IT flexibility and services reuse. These findings complement the predominantly technical literature on SOA and also specify which governance mechanisms are needed to achieve increased integration, scalability, modularity, and reuse.

7 References

Al-Natour, S., Benbasat, I., and Cenfetelli, R. 2011. "The adoption of online shopping assistants: Perceived similarity as an antecedent to evaluative beliefs", *Journal of the Association for Information Systems* (12:5), pp. 347–374.

Armstrong, J.S. and Overton, T.S. 1977. "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research* (14:3), pp. 396–402.

Arsanjani, A., Ghosh, S., Allam, A., Abdollah, T., Ganapathy, S., and Holley, K. 2008. "SOMA: A method for developing service-oriented solutions", *IBM Systems Journal* (47:3), pp. 377–396.

Baron, R.M. and Kenny, D.A. 1986. "The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology* (51:6), pp. 1173-1182.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Becker, A., Buxmann, P., and Widjaja, T. 2009. "Value potential and challenges of service-oriented architectures - a user and vendor perspective", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Beimborn, D., Joachim, N., and Weitzel, T. 2012. "Do service-oriented IT architectures facilitate business process outsourcing? A study in the german service industry", *Zeitschrift für Betriebswirtschaft (ZfB), Journal of Business Economics* (82:Special Issue 4), pp. 77–108.

Bergkvist, L. and Rossiter, J.R. 2007. "The predictive validity of multiple-item versus single-item measures of the same constructs", *Journal of Marketing Research* (44:2), pp. 175–184.

Bertolino, A. and Polini, A. 2009. "SOA test governance: Enabling service integration testing across organization and technology borders", in: *Proceedings of the International Conference on Software Testing, Verification and Validation Workshops*. Denver, CO, USA, pp. 277–286.

Bieberstein, N., Bose, S., Fiammante, M., Jones, K., and Shah, R. 2005a. *Service-oriented architecture (SOA) compass: Business value, planning, and enterprise roadmap*. Upper Saddle River, NJ: IBM Press.

Bieberstein, N., Bose, S., Walker, L., and Lynch, A. 2005b. "Impact of service-oriented architecture on enterprise systems, organizational structures, and individuals", *IBM Systems Journal* (44:4), pp. 691–708.

Byrd, T.A. and Turner, D.E. 2000. "Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct", *Journal of Management Information Systems* (17:1), pp. 167–208.

Chanopas, A., Krairit, D., and Khang, D.B. 2006. "Managing information technology infrastructure: A new flexibility framework", *Management Research News* (29:10), pp. 632–651.

Chen, H.-M. 2008. "Towards service engineering: Service orientation and business-IT alignment", in: *Proceedings of the 41st Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society.

Chin, W.W. 1998. "The partial least square approach to structural equation modeling", in: *Modern methods for business research,* G.A. Marcoulides (ed.). Mahwah, NJ, USA: Lawrence Erlbaum Associates, pp. 295–336.

Chung, S.H., Rainer, R.K., and Lewis, B.R. 2003. "The impact of information technology infrastructure flexibility on strategic alignment and applications implementation", *Communications of the Association for Information Systems* (11:1), pp. 191–206.

Coltman, T., Devinney, T.M., and Midgley, D.F. 2011. "Customer relationship management and firm performance", *Journal of Information Technology* (26:3), pp. 205–219.

Curbera, F., Khalaf, R., Mukhi, N., Tai, S., and Weerawarana, S. 2003. "The next step in web services", *Communications of the ACM* (46:10), pp. 29–34.

de Haes, S. and van Grembergen, W. 2009. "An exploratory study into IT governance implementations and its impact on business/IT alignment", *Information Systems Management* (26:2), pp. 123–137.

Derler, P. and Weinreich, R. 2007. "Models and tools for SOA governance", in: *Trends in enterprise application architecture,* D. Draheim and G. Weber (eds.). Berlin: Springer, pp. 112–126.

Duncan, N.B. 1995. "Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measure", *Journal of Management Information Systems* (12:2), pp. 37–57.

Erickson, J. and Siau, K. 2008. "Web services, service-oriented computing, and service-oriented architecture: Separating hype from reality", *Journal of Database Management* (19:3), pp. 42–54.

Esswein, W., Weller, J., Starke, J., and Juhrisch, M. 2009. "Identifikation von Services aus Geschäftsprozessmodellen durch automatisierte Modellanalyse", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 513–522.

Gefen, D., Straub, D.W., and Boudreau, M.-C. 2000. "Structural equation modeling and regression: Guidelines for research practice", *Communications of the Association for Information Systems* (4:1), pp. 1–77.

Hagel, J. and Brown, J.S. 2005. *The only sustainable edge: Why business strategy depends on productive friction and dynamic specialization*. Boston, Mass.: Harvard Business School Press.

Heffner, R. 2009. "Insights for CIOs: SOA and beyond", *Forrester Research*.

Hirschheim, R., Welke, R., and Schwarz, A. 2010. "Service-oriented architecture: Myths, realities, and a maturity model", *MIS Quarterly Executive* (9:1), pp. 37–48.

Joachim, N. 2011. "A literature review of research on service-oriented architectures (SOA): Characteristics, adoption determinants, governance mechanisms, and business impact", in: *Proceedings of the 17th Americas Conference on Information Systems (AMCIS)*. Detroit, MI, USA.

Joachim, N., Beimborn, D., Schlosser, F., and Weitzel, T. 2011. "Does SOA create or require IT/business collaboration? Investigating SOA's potential to reduce the gap between IT and business", in: *Proceedings of the 32nd International Conference on Information Systems (ICIS)*. Shanghai, China.

Kavianpour, M. 2007. "SOA and large scale and complex enterprise transformation", in: *Proceedings of the 5th International Conference on Service-Oriented Computing (ICSOC)*. Vienna, Austria, pp. 530–545.

Keen, M., Allison, A., Dan, A., Falkl, J., Hately, A., Peng, D., and Richter, J. 2008. "Case study: SOA governance scenario". IBM Corporation.

Klein, R. and Rai, A. 2009. "Interfirm strategic information flows in logistics supply chain relationships", *MIS Quarterly* (33:4), pp. 735–762.

Kohnke, O., Scheffler, T., and Hock, C. 2008. "SOA-governance - an approach to management of service oriented architecture", *Wirtschaftsinformatik* (50:5), pp. 408–412.

Krafzig, D., Banke, K., and Slama, D. 2005. *Enterprise SOA: Service-oriented architecture best practices*. Upper Saddle River, NJ: Prentice Hall.

Kristensen, K. and Eskildsen, J. 2010. "Design of PLS-based satisfaction studies", in: *Handbook of partial least squares: Concepts, methods and applications,* V.E. Vinzi, W.W. Chin, J. Henseler, and H. Wang (eds.). Heidelberg: Springer, pp. 247–277.

Kumar, R.L. 2004. "A framework for assessing the business value of information technology infrastructures", *Journal of Management Information Systems* (21:2), pp. 11–32.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007. "SOA and information sharing in supply chain: "How" information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Lawshe, C.H. 1975. "A quantitative approach to content validity", *Personnel Psychology* (28:4), pp. 563–575.

Lee, J.H., Shim, H.-J., and Kim, K.K. 2010. "Critical success factors in SOA implementation: An exploratory study", *Information Systems Management* (27:2), pp. 123–145.

Leusse, P., Dimitrakos, T., and Brossard, D. 2009. "A governance model for SOA", in: *Proceedings of the IEEE International Conference on Web Services (ICWS)*. Los Angeles, CA, USA, pp. 1020–1027.

Lewis, B.R., Snyder, C.A., and Rainer, R.K. 1995. "An empirical assessment of the information resource management construct", *Journal of Management Information Systems* (12:1), pp. 199–223.

Liang, H., Saraf, N., Hu, Q., and Xue, Y. 2007. "Assimilation of enterprise systems: The effect of institutional pressures and the mediating role of top management", *MIS Quarterly* (31:1), pp. 59–87.

Lowry, P.B., Romans, D., and Curtis, A. 2004. "Global journal prestige and supporting disciplines: A scientometric study of information systems journals", *Journal of the Association for Information Systems* (5:2), pp. 29–77.

Mitra, T. 2005. "A case for SOA governance". retrieved 08/20/2010, from http://www.ibm.com/developerworks/webservices/library/ws-soa-govern/.

Moore, G.C. and Benbasat, I. 1991. "Development of an instrument to measure the perceptions of adopting an information technology innovation", *Information Systems Research* (2:3), pp. 192–222.

Niemann, M., Eckert, J., Repp, N., and Steinmetz, R. 2008. "Towards a generic governance model for service-oriented architectures", in: *Proceedings of the 14th Americas Conference on Information Systems (AMCIS)*. Toronto, ON, Canada, pp. 1–10.

Nunnally, J.C. 1978. *Psychometric theory*, (2. ed.). New York, NY: McGraw-Hill.

Papazoglou, M.P. and Heuvel, W.-J. 2007. "Service oriented architectures: Approaches, technologies and research issues", *The VLDB Journal* (16:3), pp. 389–415.

Peltz, C. 2003. "Web services orchestration and choreography", *Computer* (36:10), pp. 46–52.

Petter, S., Straub, D., and Rai, A. 2007. "Specifying formative constructs in information systems research", *MIS Quarterly* (31:4), pp. 623–656.

Preacher, K.J. and Hayes, A.F. 2004. "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods* (36:4), pp. 717–731.

Ren, M. and Lyytinen, K.J. 2008. "Building enterprise architecture agility and sustenance with SOA", *Communications of the Association for Information Systems* (22:1), pp. 75–86.

Ringle, C.M., Wende, S., and Will, A. 2007. "SmartPLS 2.0 (M3) Beta". Hamburg.

Sabherwal, R. and Chan, Y.E. 2001. "Alignment between business and IS strategies: A study of prospectors, analyzers, and defenders", *Information Systems Research* (12:1), pp. 11-33.

Sanchez, R. and Mahoney, J.T. 1996. "Modularity, flexibility, and knowledge management in product and organization design", *Strategic Management Journal* (17:Winter Special Issue), pp. 63–76.

Saran, C. 2006. "SOA will fail without governance warns gartner". retrieved 08/11/2010, from http://www.computerweekly.com/Articles/2006/09/07/218322/soa-will-fail-without-governance-warns-gartner.htm.

Schelp, J. and Aier, S. 2009. "SOA and EA – sustainable contributions for increasing corporate agility", in: *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA.

Schepers, T.G.J., Iacob, M.E., and van Eck, P.A.T. 2008. "A lifecycle approach to SOA governance", in: *Proceedings of the 2008 ACM symposium on Applied computing*. Fortaleza, Ceara, Brazil: ACM, pp. 1055–1061.

Schilling, M.A. 2000. "Toward a general modular systems theory and its application to interfirm product modularity", *Academy of Management Review* (25:2), pp. 312–334.

Sedera, D. and Gable, G.G. 2010. "Knowledge management competence for enterprise system success", *Journal of Strategic Information Systems* (19:4), pp. 296–306.

Shrout, P. and Bolger, N. 2002. "Mediation in experimental and nonexperimental studies: New procedures and recommendations", *Psychological Methods* (7:4), pp. 422–445.

Siedersleben, J. 2007. "SOA revisited: Component orientation in system landscapes", *Wirtschaftsinformatik* (49:Special Issue), pp. 110–117.

Simon, H.A. 1962. "The architecture of complexity: American philosophical society", *Proceedings of the American Philosophical Society* (106:6), pp. 467–482.

Strnadl, C.F. 2007. "Bridging architectural boundaries design and implementation of a semantic BPM and SOA governance tool", in: *Proceedings of the 5th International Conference on Service-Oriented Computing (ICSOC)*. Vienna, Austria, pp. 518–529.

Tewary, A.K., Kosalge, P., and Motwani, J. 2009. "Piloting service oriented architecture—a case study in the oil industry", in: *Proceedings of the 15th Americas Conference on Information Systems (AMCIS)*. San Francisco, CA, USA, pp. 1–12.

Tiwana, A., Bharadwaj, A., and Sambamurthy, V. 2003. "The antecedents of information systems development capability in firms: A knowledge integration perspective", *Proceedings of the 24th International Conference in Information Systems (ICIS)*. Seattle, WA, USA, pp. 246-258.

Varadan, R., Channabasavaiah, K., Simpson, S., Holley, K., and Allam, A. 2008. "Increasing business flexibility and SOA adoption through effective SOA governance", *IBM Systems Journal* (47:3), pp. 473–488.

Viering, G., Legner, C., and Ahlemann, F. 2009. "The (lacking) business perspective on SOA - critical themes in SOA research", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 45–54.

Walker, L. 2007. "IBM business transformation enabled by service-oriented architecture", *IBM Systems Journal* (46:4), pp. 651–667.

Worren, N., Moore, K., and Cardona, P. 2002. "Modularity, strategic flexibility and firm performance: A study of the home appliance industry", *Strategic Management Journal* (23:12), p. 1123.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

Yu, T., Zhang, Y., and Lin, K.-J. 2007. "Efficient algorithms for web services selection with end-to-end QoS constraints", *ACM Transactions on the Web* (1:1), pp. 1–26.

Zhu, K. and Kraemer, K.L. 2002. "E-commerce metrics for net-enhanced organizations: Assessing the value of e-commerce to firm performance in the manufacturing sector", *Information Systems Research* (13:3), pp. 275–295.

Appendix A

Construct (Source)	Label	Indicator (Scales: "fully disagree" to "fully agree" (5- or 7-step Likert scale); if not stated otherwise) *(translated from German)*	Loadings (flexibility model)	Loadings (reuse model)
Reuse	REU1	Usually, new functions of our systems can be realized by reusing existing components (e. g. services).	n/a	.873**
	REU2	Many of our systems consist of reusable software components.		.937**
	REU3	Functionality of our legacy systems can easily be reused in other systems.		.819**
Modularity (Chung et al. 2005; Tallon 2008)	MOD1	We can add new functionality to our systems without having serious problems.	.773**	.791**
	MOD2	Exchanging or modifying single components does not affect our IT infrastructure.	.789**	.778**
	MOD3	Our systems consist of clearly separated modules.	.826**	.818**
Integration (Byrd and Turner 2000; Chanopas et al. 2006)	ITG1	Exchanging data between different systems is very easy.	.891**	n/a
	ITG2	Data of one system can be easily used in other systems.	.882**	
	ITG3	We can easily create consolidated views about all data belonging to a customer.	.759**	
	ITG4	We can integrate additional data formats (e. g. EDI, XML) easily in our applications.	.732**	
Scalability (Chanopas et al. 2006; Gable et al. 2008)	SCA1	Out IT infrastructure can easily compensates peaks in transaction volumes.	.798**	n/a
	SCA2	Our IT infrastructure offers sufficient capacity in order to fulfill additional orders.	.843**	
	SCA3	The performance of our IT infrastructure completely fulfills our business needs.	.886**	
New decision-making body	DMB1	New decision structures (e.g. center of excellence, SOA board) have been created in order to define / enforce SOA related standards within the organization.	1.000	1.000
Standards	STD1	The interfaces of our applications are based on well-established standards.	.904**	.856**
	STD2	We follow standards (process, functional, data models) for designing our interfaces.	.756**	.818**
Service management	SMM1	We have established a central service management (development, runtime control, and billing).	.805**	.795**
	SMM2	Business units are charged per transaction for using services	.719**	.748**
	SMM3	For the internal use of services service-level-agreements between service provider and consumer exist.	.717**	.699**
Service development	SDP1	For the approval of new services, we have implemented a clearly defined process.	.918**	.905**
	SDP2	In our organization, mandatory service design rules are consequently adhered.	.770**	.791**
	SDP3	Our SOA governance successfully ensures that service reuse is maximized.	.727**	.726**
Qualification	QUA1	Our IT is able to quickly comprehend the principles of service-orientation.	.828**	.848**
	QUA2	Our IT has the necessary experiences for implementing SOA.	.918**	.914**
	QUA3	Our IT possesses comprehensive knowledge about the SOA concept.	.919**	.903**
IT/business communication	IBC1	IT and business units can communicate in a common (professional) language.	.829**	.845**
	IBC2	Between IT and business units communication difficulties exist only seldom.	.885**	.876**
	IBC3	IT and business units can explain their concerns to the other side.	.843**	.836**
Collaborative work of business units	CWB1	Business units identify collaboratively synergies in business processes.	.922**	.913**
	CWB2	Business units work collaboratively on the business requirements of business services.	.925**	.933**
Orga. size	OSI	Logarithm of total number of employees (source: secondary data)		
ITIL	ITIL	We have all ITIL processes/functions implemented in our company.		
COBIT	COBIT	We have all COBIT processes implemented in our company.		
Industry type	INT1	3 dummy variables: logistics & trade, financial services, and IT & communication (secondary data)		
** $p \leq .01$				

Table 7. Indicators used in the measurement model

Appendix B

Latent variable	C.R.	AVE	Reuse	Modularity	Integration	Scalability	New decision-making body	Standards	Service management	Service development	Qualification of employees	IT/business communication	Collaborative work of business units
Reuse	n/a .909	n/a .770	n/a .878										
Modularity	.839 .838	.634 .633	n/a .611	.796 .796									
Integration	.890 n/a	.671 n/a	n/a n/a	.555 n/a	.819 n/a								
Scalability	.880 n/a	.710 n/a	n/a n/a	.371 n/a	.276 n/a	.843 n/a							
New decision-making body	1.000 1.000	1.000 1.000	n/a -.043	-.094 -.094	-.166 n/a	-.021 n/a	1.000 1.000						
Standards	.818 .824	.694 .701	n/a .377	.441 .446	.396 n/a	.286 n/a	.053 .072	.833 .837					
Service management	.792 .792	.560 .560	n/a .424	.306 .304	.219 n/a	.062 n/a	.488 .488	.223 .229	.748 .748				
Service development	.849 .851	.655 .657	n/a .220	.301 .299	.210 n/a	.051 n/a	.413 .417	.117 .122	.387 .381	.809 .810			
Qualification of employees	.919 .918	.791 .790	n/a .193	.237 .241	.263 n/a	.233 n/a	.218 .211	.077 .071	.149 .151	.307 .310	.889 .889		
IT/business communication	.889 .889	.727 .727	n/a .298	.438 .438	.385 n/a	.274 n/a	-.040 -.037	.208 .209	.356 .359	.355 .354	.162 .163	.853 .853	
Collaborative work of business units	.921 .920	.853 .852	n/a .259	.446 .446	.328 n/a	.051 n/a	-.055 -.055	.121 .117	.328 .334	.333 .329	.194 .204	.341 .339	.923 .923

Table 8. Reliability, convergent and discriminant validity of both model estimations (upper values: flexibility model, lower values: full reuse model; (correlations of latent variables and square root of AVE in shaded cells)).

Appendix C

	Reuse	Modularity	Integration	Scalability	New decision-making body	Standards	Service management	Service development	Qualification of employees	IT/business communication	Collaborative work of business units
REU1	.873	.439	n/a	n/a	-.058	.306	.398	.115	.148	.169	.191
REU2	.937	.622	n/a	n/a	.001	.422	.422	.240	.133	.284	.255
REU3	.819	.537	n/a	n/a	-.065	.247	.287	.217	.237	.331	.233
MOD1	.569	.773	.484	.361	-.099	.375	.190	.254	.277	.341	.325
MOD2	.425	.778	.427	.358	-.173	.378	.194	.211	.043	.261	.335
MOD3	.452	.818	.414	.170	.042	.320	.346	.253	.239	.442	.410
ITG1	n/a	.492	.891	.273	-.229	.366	.138	.194	.231	.344	.312
ITG2	n/a	.526	.882	.175	-.194	.384	.185	.226	.219	.351	.383
ITG3	n/a	.406	.759	.242	-.001	.253	.226	.126	.229	.271	.183
ITG4	n/a	.367	.732	.234	-.044	.261	.202	.109	.189	.281	.128
SCA1	n/a	.378	.262	.798	-.120	.286	.004	.096	.081	.210	.098
SCA2	n/a	.279	.180	.843	-.031	.112	.026	-.012	.145	.188	.013
SCA3	n/a	.293	.245	.886	.057	.286	.099	.039	.304	.272	.024
DMB1	-.043	-.094	-.166	-.021	1.000	.072	.488	.417	.218	-.037	-.055
STD1	.353	.374	.414	.333	-.038	.856	.172	.063	.091	.175	.112
STD2	.274	.373	.213	.103	.170	.756	.214	.153	.028	.177	.087
SMM1	.340	.221	.246	-.065	.384	.250	.795	.377	.137	.265	.227
SMM2	.321	.235	.119	.035	.345	.162	.719	.150	.041	.254	.237
SMM3	.288	.233	.117	.179	.366	.098	.699	.334	.164	.287	.288
SDP1	.192	.330	.220	.049	.288	.166	.264	.905	.224	.313	.353
SDP2	.173	.221	.127	-.012	.317	.051	.262	.770	.323	.301	.181
SDP3	.176	.134	.139	.095	.483	.049	.505	.726	.236	.250	.250
QUA1	.199	.211	.254	.146	.110	.109	.229	.247	.828	.197	.295
QUA2	.195	.192	.202	.248	.202	-.010	.089	.265	.914	.084	.156
QUA3	.115	.239	.245	.225	.259	.104	.089	.317	.903	.155	.086
IBC1	.283	.373	.313	.192	.044	.163	.375	.273	.126	.829	.260
IBC2	.299	.405	.354	.351	-.156	.190	.176	.223	.099	.876	.258
IBC3	.155	.337	.312	.122	.044	.185	.402	.454	.212	.836	.375
CWB1	.207	.393	.321	.064	-.052	.152	.195	.302	.197	.328	.913
CWB2	.267	.432	.286	.030	-.050	.072	.409	.313	.181	.303	.925

Table 9. Cross-loadings of indicators from flexibility model and reuse model (shaded cells contain the minimum loadings of both models; other cells contain the maximum cross-loadings of both models)

Appendix D

Survey-based single-informant approaches may lack validity because of common method bias (CMB). We took several measures to address this severe threat, including using differing scale formats for the different constructs and distributing two different versions of the questionnaire with altered item sequences. While the latter approach does not reduce CMB, one can test whether context or ordering of questions influences the answers. A group comparison between the different versions of the survey showed no differences.

Further, we tested the validity of our results for potential CMB by using the Harman single factor test, which showed that no single component explains the majority of the overall variance (the largest component explained only up to 25.6%).

Moreover, we used a theoretically unrelated marker variable[56] to operationalize a common method factor in both the flexibility and reuse models (Lindell and Whitney 2001; Podsakoff et al. 2003). To test for the significance of CMB and partial out its effect on the model paths, we added additional links from the common method factor to all dependent variables (for the flexibility model: modularity, integration, and scalability; for the reuse model: modularity and reuse) and observed whether changes appeared in the significance levels of path weights and in the R^2 of the dependent variables. The differences identified in the comparisons for both models are summarized in the following table and give no indication of substantial CMB as well. The increases in R^2 (up to .043) and path coefficients (up to.063) are very small. While one would expect that adding a marker variable representing method variance would result in decreases of path significances of the original model (as the marker variable "pulls" the correlations to the extent of CMB), the level of significances for four of the hypothesized paths (cf. Table 10) in fact increases when adding the common method factor to the model. Thus, using the marker variable indicates that partialling CMB out could uncover even stronger relationships in the research model. Consequently, the results of our model estimations can be treated as conservative lower bound, which may have rejected hypotheses although being true. At the same time, it is unlikely that there were any type-I-errors due to CMB.

Overall, the results of the tests show that CMB is not a major issue in our data.

[56] Marker: "IT should facilitate access to new markets and regions." rated on a 7-Likert scale from "not an IT goal at all" to "important IT goal."

	Flexibility model	Reuse model
Largest difference in R^2	.043	.014
Range of changes in path coefficients	-.031 to .063	-.016 to .034
Changes in level of significance:		
New decision-making body → modularity	Sig. level changes from .05 to .01	*no change*
Service management → integration	Sig. level changes from .1 to .05	*no change*
Service development → integration	Sig. level changes from not significant to .1	*no change*
Collaborative work of business units → integration	Sig. level changes from not significant to .1	*no change*
Collaborative work of business units → reuse	*no change*	Sig. level changes from .1 to not significant

Table 10. Results of marker variable approach for testing the existence common method bias

References

Byrd, T.A. and Turner, D.E. 2000. "Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct", *Journal of Management Information Systems* (17:1), pp. 167–208.

Chanopas, A., Krairit, D., and Khang, D.B. 2006. "Managing information technology infrastructure: A new flexibility framework", *Management Research News* (29:10), pp. 632–651.

Chung, S.H., Byrd, T.A., Lewis, B.R., and Ford, F.N. 2005. "An empirical study of the relationships between IT infrastructure flexibility, mass customization, and business performance", *SIGMIS Database* (36:3), pp. 26–44.

Gable, G.G., Sedera, D., and Chan, T. 2008. "Re-conceptualizing information system success: The IS-impact measurement model", *Journal of the Association for Information Systems* (9:7), pp. 1–32.

Lindell, M.K. and Whitney, D.J. 2001. "Accounting for common method variance in cross-sectional research designs", *Journal of Applied Psychology* (86:1), pp. 114–121.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. 2003. "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Psychology* (88:5), pp. 879–903.

Tallon, P.P. 2008. "Inside the adaptive enterprise: An information technology capabilities perspective on business process agility", *Information Technology and Management* (9:1), pp. 21–36.

PAPER VIII

DOES SOA CREATE OR REQUIRE IT/BUSINESS COLLABORATION? INVESTIGATING SOA'S POTENTIAL TO REDUCE THE GAP BETWEEN IT AND BUSINESS

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Abstract

By extending the research on identifying the possible benefits of Service-Oriented Architectures (SOA), we investigate how SOA delivers its value in an organization. One perspective in the existing literature suggests that service orientation works through creating better IT/Business collaboration as the "services" concept is a shared mental model that reduces the mental gap between IT and business units. Another perspective proposes that SOA benefits require IT/Business collaboration in the first place as IT and business must closely collaborate in order to leverage SOA's potential.

We develop a theoretical model to understand how service orientation and close collaboration between IT and business departments are related. An analysis using data from 122 organizations reveals that SOA does not advance - but rather requires - close collaboration between the IT and business departments (i.e., collaboration is a moderator, not mediator, between SOA and its impacts). Therefore, close IT/business collaboration is an important success factor for realizing SOA's value potential and must be established using other means.

1 Introduction

Service-Oriented Architectures (SOA) have been a much debated academic and practitioner topic over the past decade (Viering et al. 2009). The concept of service orientation has advanced from a pure IT focus to an overarching concept engaging the business side, as well (Cherbakov et al. 2005; Joachim 2011). According to Forrester Research, 84% of the largest 2,000 organizations worldwide have implemented an SOA (Heffner 2010). Complementary to the increasing interest of practitioners, recent research has investigated the concept of SOA to reveal what specific benefits SOA is able to deliver (Beimborn and Joachim 2011; Joachim et al. 2011a; Kumar et al. 2007; Oh et al. 2007; Tafti et al. 2008). However, the same Forrester study shows that only 12% of firms have fully realized the anticipated benefits. At the same time, despite a maturing academic literature on service orientation, there remains a dearth of research into how exactly SOA acts in an organization.

We extend existing literature which identifies *what* possible benefits SOA can deliver, by adding a more theoretical perspective and analyzing *how* SOA delivers its benefits. Krafzig et al. (2005, p. 68) argue that "being able to talk about the specific nature of different services at an abstract level will enable the different stakeholders in an SOA project [...] to communicate their ideas and concerns more effectively". Also, Antikainen and Pekkola (2009, p. 1) highlight that "Service-Oriented Architecture (SOA) has gained focus as a driver for bridging and aligning business and IT-oriented views in information system development." Another role is pointed out by Yoon and Carter (2007, p. 1) suggesting "that SOA requires extremely high levels of organization-IT alignment to achieve reported benefits". These quotes distinguish two different roles when considering *how* SOA delivers its benefits: (1) The first two statements propose that SOA will improve IT/business collaboration and thus bring business and IT together. Hence, the common element of services, which is introduced to an organization by implementing an SOA, allows the reduction of the "mental gap" that exists between IT and business departments, so that they can work together more effectively and thus achieve the desired goals; (2) The last quote assumes that business and IT must work closely together in order to leverage SOA's full potential benefits. Thus, the first possibility for explaining SOA's value is its mediating role in close IT/business collaboration, while the second explanation assigns a moderating role to close IT/business collaboration.

We aim to compare the two different relationships identified in the literature, putting the close collaboration between business and IT departments into the focus of our investigation. For our research model we adopt the perspective of shared mental models (SMMs) and discuss in particular the social implications which arise when firms implement an SOA, allowing us to examine the relationships between service orientation and close IT/business collaboration. Our guiding research question is:

RQ: Does SOA create or require IT/Business collaboration?

The remainder of the paper is structured as follows: The next section will develop our research model and thereby introduce the relevant related literature. Then, the empirical approach and the results are presented. Lastly, we discuss our results, show our contributions and highlight opportunities for future research.

2 Model Development

This section explains the development of our research models (Figure 1). Our main focus is not to show that SOA increases technical IT flexibility but rather to shed light on *how* leveraging IT/business collaboration affects SOA's benefits.

2.1 Implementing Service-Oriented Architectures for Increasing IT flexibility

2.1.1 Service-Oriented Architectures

There are varying definitions of the concept of SOA in the existing literature. While some associate SOA only with IT aspects, others also include a business dimension:

- Krafzig et al. (2005, p. 57) are primarily looking at SOA from a technological point of view when defining SOA as "a software architecture that is based on the key concepts of an application frontend, service, service repository, and service bus".
- In contrast, Lublinsky concentrates on the business aspects: "SOA can be defined as an architectural style promoting the concept of business-aligned enterprise service as the fundamental unit of designing, building, and composing enterprise business solutions." (Lublinsky 2007). This view is in line with the definition of a Service-Oriented Enterprise (SOE) (Janssen and Joha 2008, p. 35): "The SOE is an enterprise that is modularized in business domains." Thus, a service-oriented view at the business layer establishes shared service centers, which support creating "new products […] by orchestrating the services provided by the service centers".
- Bieberstein et al. (2005, p. 5) cover both extremes and define SOA as a "framework for integrating business processes and supporting IT infrastructure as secure, standardized components – services – that can be reused and combined to address changing business priorities".

Similarly, the way the degree of SOA adoption has been operationalized in the few existing quantitative studies varies widely: For instance, Kumar et al. (2007) conceptualize SOA by looking at the application of technologies commonly used for implementing SOA (XML and Web Services). Tafti et al. (2008, p. 13) add a first business aspect to their SOA concept by considering "the number of business functions for which SOA is used", in addition to technical aspects such as "the deployment of services-based architecture" or XML and Web Services to measure SOA using four single items. Oh et al. (2007) chose to investigate the IT aspects in more detail and assessed general architectural design principles as well as common technologies (i.e., XML, WSDL, SOAP, and UDDI). However, SOA research should apply a more complete approach, which holistically and consistently assesses the various definitions and conceptualizations of SOA.

In order to unify the different conceptualizations of SOA, we propose using the concept of enterprise architecture (EA), which comprises all layers of an organization (from technology to business). Even though the number of layers differs between the EA frameworks which have been proposed in the existing literature, a common denominator can be found. While Winter and Fischer (2007) identify five layers, Brown and Karamouzis (2001) focus on three layers, similar to Meschke and Baumoel (2010), who condense the number of Winter and Fischer's EA representation down to three. Additionally, the widely applied EA framework TOGAF 9 (The Open Group Architecture Framework) (The Open Group 2009) uses only three layers for assessing the EA: business architecture, IS architecture (i.e., data and application architecture), and technology architecture. As a result we assess the degree of service orientation on each of the three layers and, in addition, analyze the service-oriented fit between the three different layers as a complementary aspect of SOA adoption across all three layers of EA. In summary, we assess the degree of SOA adoption according to the following four dimensions:

(1) S*ervice-oriented business architecture:* The degree of service orientation of the business architecture is identified by examining whether the design of the business activities follows the service-oriented paradigm (i.e., identify their core capabilities by using services-based modeling concepts for modeling business processes or to support organizing the enterprise in a service-oriented way by running and offering centralized and non-redundant (shared) business services (Janssen and Joha 2008)).

(2) S*ervice-oriented IS architecture*: The service orientation of the IS architecture is considered according to the degree to which the IS architecture actually follows the paradigm of service orientation. This includes the design principles of loose coupling, division of reusable logic, abstraction, and composability (Erl 2004).

(3) S*ervice-oriented technology architecture*: Service orientation of the technology architecture is determined by the extent of the use of technologies which are typical for implementing SOA, such as XML, Web Services, enterprise service bus (ESB), service registry/repository, and business process execution language (BPEL) (cf. Kumar et al. 2007; Oh et al. 2007)

(4) *Fit of service-oriented architectures:* Lastly, while the three previous aspects focus on the degree of service orientation on each layer separately, we also investigate the scope to which particular existing business processes are actually based on SOA. Thus, this dimension assesses the fit between each of the previous three architecture layers (i.e., (1), (2), and (3)), as business processes are more likely to be successfully implemented using SOA when all three layers are aligned with regard to the respective business process.

This conceptualization of SOA defines a comprehensive, multidimensional measurement model to quantitatively capture a more complete picture of the degree of SOA adoption, and consequently, its impact.

2.1.2 Technical IT Flexibility

The most obvious reason and most frequently mentioned goal for adopting the SOA paradigm is to increase the flexibility of IT infrastructure (Yoon and Carter 2007). According to Duncan, IT infrastructure flexibility is "the ability of the IS department to respond quickly and cost-effectively to systems demands, which evolve with changes in business practices or strategies" (1995, p. 44), covering both technical and human aspects of the IT function. In our research we draw on the work of Byrd and Turner (2000) and adopt their conceptualization of *technical* IT infrastructure flexibility (referred to as IT flexibility). Accordingly, technical IT infrastructure flexibility consists of two key characteristics: *integration*, which means that different components can be connected and are able to exchange information; and *modularity*, which relates to "the ability to add, modify, and remove any software, hardware, or data components of the infrastructure with ease and with no major overall effect" (Byrd and Turner 2000, p. 171).

Chanopas et al. (2006) suggest extending this concept and propose five additional characteristics of technical IT infrastructure flexibility (the number of IT experts out of a total of 11 interviewees reporting the respective characteristic of IT infrastructure flexibility is given in parentheses): scalability (11), continuity (2), rapidity (2), facility (1), and modernity (6). Besides the characteristics already defined by Byrd and Turner (2000), scalability is the only one of the five newly identified characteristics, which is consistently reported by all 11 IT experts in Chanopas et al. (2006). The other characteristics are only reported by a minority of the 11 IT experts and can thus be considered to be of less importance. Scalability has been defined as "the degree to which hardware/software can be scaled and upgraded on existing infrastructure" (p. 645) and is of particular importance regarding the effect of service orientation. Solutions based on SOA are generally expected to exhibit a higher scalability than point-to-point connections since an enterprise service bus (ESB) is applied for application integration. One problem with point-to-point connections is the rapid slope of handling complexity with an increasing number of systems to be integrated (Papazoglou and Heuvel 2007).

In our model, integration, modularity, and scalability represent the sub-dimensions of technical IT flexibility. As described above, when firms implement an SOA, they strive to create modular services. Consequently, modularity is a key design principle of SOA. In a good SOA implementation, services are clearly separated, allow (re-)use in various situations and integration wherever necessary (Baskerville et al. 2005; Yoon and Carter 2007). Moreover, when implementing SOA, firms aim to improve the scalability of their IT infrastructure (Henningsson et al. 2007; Yoon and Carter 2007). The higher the IT scalability is, the easier the handling when indicators such as number of users, workload or transaction volume increase (Chanopas et al. 2006; Kumar 2004). For example, multiple enterprise service buses (ESBs) can be used and multiple versions of the same service can be registered to avoid bottlenecks (resulting from increasing transaction volume) in an SOA.

Hypothesis (H1): SOA increases technical IT flexibility.

2.2 Close IT/Business Collaboration as Explanatory Factor of the Impact of SOA

2.2.1 Theoretical Foundations

Building on a large body of literature on the crucial role of collaboration between individuals and organizational units for exploiting the potential of a firm's IT, we investigate how IT/business collaboration is interrelated to SOA. While IT/business collaboration can be examined at all organizational levels, our focus is on the IT/business interface at the tactical and operational level because the implementation of SOA is very much about (business) services, and thus, predominantly involves business and IT personnel in projects and daily business.

Collaboration between business and IT refers mainly to how close the working relationship is between both sides, i.e., how effective information sharing is, to what extent mutual understanding is present, and how well decisions and tasks are coordinated. Mastering these enhancing relationships, which are built upon processes among human actors that allow exchanging knowledge and forming attitudes (Reich and Kaarst-Brown 2003), is considered to be a core IS capability (Feeny and Willcocks 1998; Tiwana 2003; Wade and Hulland 2004). While there is little doubt about the value of good collaboration between business and IT, it is less clear how and to what extent these partly indirect effects contribute to IT-based benefits, and how they can be developed and maintained, i.e., which mechanisms are expected to lead to a better IT/business collaboration. Consequently, more research on the role of IT/business collaboration is needed, particularly at non-strategic levels, and also into IT/business collaboration antecedents.

The role of collaboration between business and IT has already been extensively studied at the strategic level, by considering, for example, the relationship of chief information officers (or IT executives) and business executives (like the CEO, CFO, COO, …). Usually, the term "social dimension of alignment" or just "social alignment" is used for this kind of IT/business relationship, reflected in sub-dimensions like communication quality, mutual understanding, cognition, and trust (Reich and Benbasat 2000; Tiwana 2003). However, research in the area of social alignment has focused exclusively on the strategic level while widely neglecting tactical and operational levels (Franke et al. 2005; Tarafdar and Qrunfleh 2009). Consequently, our knowledge of the role of collaboration between IT and business at the tactical and operational level is limited. In our paper, we address this issue and consider collaboration between IT and business at the operational level covering effective and close collaboration of IT and business staff with regard to IT/IS projects and changes. Thus, we investigate what role close IT/business collaboration plays for the relationship between SOA and IT flexibility (e.g., prioritizing change requests and running IS projects). As outlined in the model development below, close IT/business collaboration can on the one hand act as an enabler (or moderator) for SOA's contribution to IT flexibility, since tight collaboration between IT and business is required to leverage SOA benefits. On the other hand, we propose that implementing the concept of services throughout the firm leads to the formation of a shared mental model, driving mutual understanding and thus increasing collaboration between IT and business. In turn, this will help to achieve a more effective SOA (in terms of IT flexibility).

In an IT/IS context, shared mental models (SMMs) have already received considerable attention (e.g., Mathieu et al. 2000; Mathieu et al. 2010; Peterson et al. 2000; Preston and Karahanna 2004). According to Mohammed et al. (2000), SMMs are concerned with an organizational understanding or mental representation of knowledge with regards to key elements of a work group's environment. Mathieu et al. (2000) have proposed distinguishing between two categories of SMMs: task and team. *Task* SMMs refer to team members holding a common schema of the task itself and, at the same time, having an understanding of how the environment may influence the task demands. *Team* SMMs exist if there is a shared understanding between the team members and how they are expected to interact (Mathieu et al. 2000; Mathieu et al. 2010). In line with the team SMMs, Langan-Fox et al. (2004) have defined an SMM as the knowledge structure shared by team members in conducting team tasks, indicating that an SMM allows team members to gain a more precise understanding and expectation of tasks that have to be performed, and increases the chance of fulfilling expectation. Considering outcomes of SMMs, prior studies have found that, among other effects, SMMs and team processes affect effectiveness in a positive way, whereby team processes (e.g., communication and coordination) have often been modeled as mediators between SMMs and effectiveness (e.g., Mathieu et al. 2000; Mathieu et al. 2010). The underlying logic is that when team members "are 'in sync', they should be better able to coordinate their actions, anticipate one another's behaviors, and otherwise execute important processes related to team performance" (Mathieu et al. 2010, p. 25).

In our model, we analyze the relationship between SOA, close collaboration between business and IT employees, and technical IT flexibility. Above, we have already hypothesized a direct relationship between SOA and IT flexibility. The remainder of our hypotheses is concerned with the role close IT/business collaboration plays in regard to the link from SOA to IT flexibility. First, we draw on close IT/business collaboration as a mechanism through which SOA increases IT flexibility, proposing the joint service concept to serve as kind of a shared mental model ("mediator model"). Second, we investigate whether close IT/business collaboration in an organization serves as a variable for successfully leveraging SOA's organizational impact ("moderator model"); even though close IT/business collaboration is not driven by the implementation of an SOA.

2.2.2 Mediator Model

Since we have conceptualized the IT/business collaboration construct at a non-strategic level, it refers to how close and effective the collaboration is within IS project and change management teams. Thus, among other aspects we are interested in whether SOA triggers and/or enhances the development of shared mental models between business and IT employees. With regard to the effect of SOA on IT/business collaboration, the underlying idea is that through the implementation of SOA a shared understanding about crucial and relevant services will arise which can help to improve knowledge exchange and close collaboration between business and IT. If this argument is supported, one possible explanation will be that, from a collaboration point of view between business and IT, service orientation creates a SMM. It facilitates shared understanding and effective knowledge transfer among relevant stakeholders by establishing a shared language. For example, "mutual understanding between business and IT people is achieved through continuous communication. SOA provides several means for this. First, SOA terminology and concepts formed a basis for IT people to comprehend the current system architecture and articulate it through common language" (Antikainen and Pekkola 2009, p. 7). When business activities are modeled in a service-oriented manner, services are the main structuration and design concept serving as a task SMM. This will lead to more effective communication and fewer misunderstandings between business and IT employees (i.e., a team SMM). This is in line with Haines and Hasemann, who found SOA initiatives to improve the relationship between business and IT, since "the service-oriented paradigm required a ‘new mindset’ from developers, that is, looking at services as an enterprise asset rather than a project deliverable” and “served as a good communication tool with the business units” (2009, p. 8). Consequently, SOA comprises social elements because implementing SOA requires business and IT employees to adopt service-oriented thinking, thus (at least partly) leaving behind old paths. In doing so, mutual understanding is likely to be improved, leading to a better collaboration between business and IT, since tasks and decisions (e.g., within IS projects or change requests) will be coordinated in close collaboration through more effective and efficient communication.

Hypothesis (H2): SOA increases close collaboration between IT and business.

Considering the effect of close IT/business collaboration on IT infrastructure flexibility, we can build on prior studies which have already shown that alignment positively influences (business and IT) flexibility (Sabherwal and Chan 2001). Avison et al. argue that “alignment can affect organizational performance by maximizing return on IT investment, by helping to achieve competitive advantage through IS, and by providing direction and flexibility to react to new opportunities” (2004, p. 225). According to Luftman and Brier, “good alignment means that the organization is applying IT in given situations in a timely way, and that these actions stay congruent with the business strategy, goals, and needs” (1999, p. 109). When business and IT employees work closely together in IS projects and change management, it is more likely that the resulting IT infrastructure is more flexible in terms of modularity, integration, and scalability, because there will be better planning and problem-solving, fewer problems through good anticipation, and fewer misunderstandings.

Hypothesis (H3): Close IT/business collaboration increases technical IT infrastructure flexibility.

For the development of hypotheses H1 through H3, we argued that close collaboration between business and IT positively influences technical IT flexibility (H3), and that SOA affects both close IT/business collaboration (H2) and technical IT flexibility (H1). In addition, we are especially interested whether close IT/business collaboration serves as a mechanism through which SOA increases IT flexibility. As we have already argued, SOA will primarily increase IT/business collaboration by generally fostering the establishment of a shared language and shared understanding and, thus, shared mental models, around the service-oriented paradigm between business and IT. Effective IT/business collaboration, in turn, increases technical IT flexibility. Regarding our conceptualization of close IT/business collaboration, this means that only if the benefits inherent in an implemented SOA are leveraged collaboratively by business and IT in joint IT projects, the full potential of SOA will be used and translated into high technical IT flexibility.

Hypothesis (H4): SOA increases technical IT flexibility through close IT/business collaboration.

2.2.3 Moderator Model

As a second, rival model, we investigate whether close IT/business collaboration in an organization serves as a variable for successfully leveraging SOA’s organizational impact, i.e., IT/business collaboration acting as moderator instead of a mediator for SOA’s effect on technical IT flexibility. Yoon and Carter’s findings from case studies “suggest that SOA requires extremely high levels of organization-IT alignment to achieve reported benefits” (2007, p. 1). Also, Antikainen and Pekkola point out that “SOA development is a continuous process where business-IT alignment needs to be invariably ensured” (2009, p. 2). However, the same articles also point out that a close collaboration between business and IT is not a prerequisite but rather an outcome of implementing SOA, as already argued in the mediating model above. For example, Yoon and Carter (2007, p. 7) highlight that a "better alignment of IT with the business" is a realized benefit of SOA and not only an important success factor for achieving other benefits from implementing SOA. This imprecise reasoning about the role of collaboration between IT and business departments for creating organizational benefits from SOA can also be found in other studies investigating mediating versus moderating effects in other research domains (Baron and Kenney 1986). Thus, to enrich the currently limited understanding in this area, we will investigate whether a direct effect between SOA and IT flexibility becomes stronger when collaboration between business and IT staff is high[57]. In this way, we argue that SOA does not establish a shared mental model itself, but that close collaboration between business and IT positively moderates the link between SOA and IT flexibility and thus helps achieve the benefits from SOA. Firms that have both an SOA in place and business and IT personnel working closely together, will be able to additionally boost their technical IT flexibility compared to other firms with less IT/business collaboration.

Hypothesis (H5): Close IT/business collaboration moderates the impact of SOA on technical IT flexibility.

Figure 1 gives an overview of the two research models for investigating the different roles of close IT/business collaboration for leveraging SOA's organizational impact in terms of technical IT flexibility.

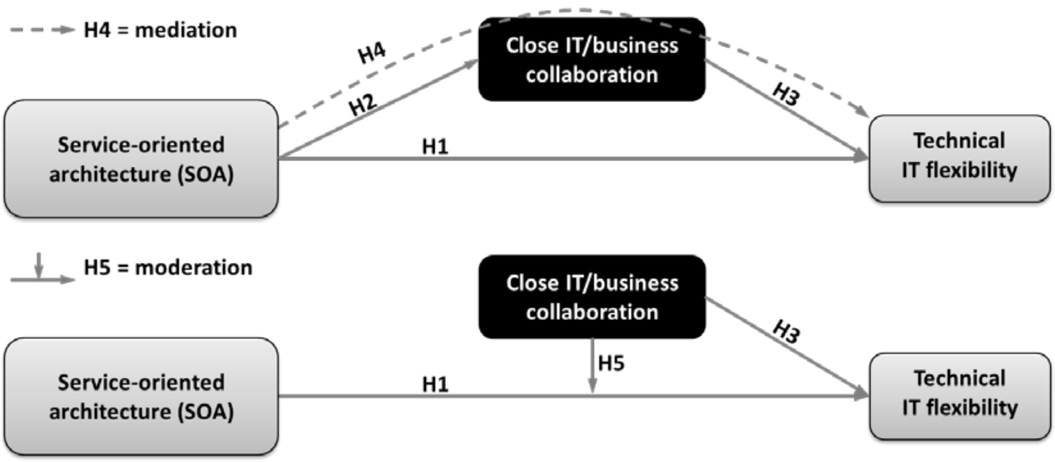

Figure 1. Research models (top: Close IT/business collaboration as mediator; bottom: Close IT/business collaboration as moderator)

3 Methodology and Results

This section describes the methodology and the data used to evaluate the proposed hypotheses as well as the results from the model evaluation.

[57] For the model development, this requires to remove the link from SOA to close IT/business collaboration (representing previous Hypothesis H2) in order to identify the interaction effect.

3.1 Data Collection and Measurement

To evaluate our research model, we conducted a survey within the German service industry (financial services, logistics, ICT etc.) because service firms are highly reliant on IT as their (often) only "production factor". We used a data set with 1,620 service companies (US SIC codes 4,000 to 8,999) and contacted each firm by phone in order to identify the manager who is in charge of the company's IT architecture (i.e., CIO, chief architect, or similar). In total, we were able to identify 1,023 managers to whom we then sent questionnaires by mail. A few weeks after the initial mailing, non-respondents were reminded of our survey and were sent the questionnaire again via mail or email, if necessary. Finally, we received 158 responses, representing a response rate of 15.4%. For analysis, we had to exclude 36 data sets due to missing values, leaving 122 complete data sets used in the following analysis.

We evaluated our research model using Partial Least Squares (PLS) (smartPLS 2 M3 (Ringle et al. 2007)), IBM SPSS Statistics 19, and Interaction version 1.4.1903.

Table 4 in the appendix provides the operationalization of the constructs. While close IT/business collaboration is operationalized by a reflective multi-item measurement model, SOA and technical IT flexibility are operationalized as second-order constructs according to the dimensions introduced in the model development section. Where possible, the items have been derived from previous literature (cf. Table 4 in the appendix).

Service-oriented architecture: As already described and discussed above, SOA is a rather complex construct. In our model, we focus on the adoption aspect of SOA and use four dimensions for measuring the degree of SOA implementation: (1) service-oriented business architecture (SOB) refers to general aspects in terms of the extent a service-oriented perspective and the services concept is implemented in regard to business activities and to structuring the (non-technical) business process level; (2) service-oriented IS architecture (SOI) addresses the use of service orientation concerning the IT architecture and applications; (3) service-oriented technology architecture (SOT) has been adapted from Kumar et al. (2007) and Oh et al. (2007) and explicitly analyzes to what extent several of the main SOA-related technologies (e.g., XML, Web Services, ESB) are used; and (4) fit of service-oriented architectures (FSA) captures the fit between all three of the aforementioned dimensions by assessing the extent to which high-level business processes (e.g., production/operations, marketing/sales/customer relations) are supported from the business layer down to the technology layer by SOA.

Technical IT flexibility: Like SOA, we have measured technical IT flexibility as a second-order construct using different dimensions in order to investigate it in a broad and comprehensive way: (1) modularity (MOD) goes back to Chung et al. (2005) and Tallon (2008) and refers to how simple and straightforward it is to modify existing, or to add new, functionality or components to IT systems without side effects on other components; (2) integration (ITG), which is based on Byrd and Turner (2000) and Chanopas et al. (2006), addresses issues related to how easy or hard it is to exchange, consolidate, and integrate data; (3) scalability (SCA) as proposed by Chanopas et al. (2006) and Gable et al. (2008) measures how capable and robust the IT infrastructure is when it comes to transaction peaks or additional orders. For each dimension, we adopted the measurement instrument from the sources referred to.

Close IT/business collaboration (IBC): This construct mainly investigates how close and good business and IT work together at non-strategic levels. Thus, aspects like collaboration in projects and operations are analyzed (Byrd and Turner 2000; Chung et al. 2003). Particularly, measures concerning close collaboration in IS development projects and the effect of change requests have been used to calculate this construct.

As control variables, we included organizational size (log of number of employees) and industry sector (3 dummy variables for financial services, ICT, and trade/logistics) data from secondary sources. Also, we used strategic IT/business alignment measured by three reflective items frequently tested in the literature (cf. e.g., Chung et al. 2003).

3.2 Evaluation of Data Quality and Measurement Model Validity

First, we tested whether the data is normally distributed. As the skewness and kurtosis values indicate certain items are not normally distributed (cf. Appendix). This is also supported by the Kolmogorov-Smirnov test and is, together with our rather small sample size of 122 datasets, the reason why we used PLS instead of covariance-based structural equation modeling (SEM).

We also assessed the possible existence of *non-response bias* by splitting the participants into two groups: (1) those organizations which responded only after reminders, and (2) those which answered immediately. The underlying assumption of this approach is that the group which responded only after reminders, shares certain similarities with those organizations which have not participated (Armstrong and Overton 1977). As the Kolmogorov-Smirnov test does not show any significant differences at $p \leq .05$, we can assume that non-response bias is not a problem in our data.

Next, we evaluated the validity and reliability of the measurement model. First, all items load highly on their associated construct ($\geq .707$), as demanded by Nunnally (1978), and they are significant at $p \leq .01$ (based on 2,000 bootstraps) (cf. Appendix). Second, the common criteria for construct reliability as well as convergent and discriminant validity are fulfilled (cf. Table 1): The composite reliabilities (C.R.) are all well above the threshold of .7 (Nunnally 1978) and the average variances extracted (AVE) are higher than Chin's suggestion of .5 (1998). Moreover, the remainder of Table 1 shows that the square root of the AVE is always higher than the cross-correlations among the latent variables, thus indicating sufficient discriminance of the measurement model (Gefen et al. 2000). Lastly, the cross-loadings of the indicators are also lower than the loadings on their associated constructs (cf. Table 5 in the appendix).

Concept	Construct (first-order)	C.R.	AVE	1	2	3	4	5	6	7	8	9	10	11
SOA	1 - Service-oriented business architecture	.954	.912	.955										
	2 - Service-oriented IS architecture	.964	.871	.594	.933									
	3 - Service-oriented technology architecture	*(formative measurement)*		.358	.526	n/a								
	4 - Fit of service-oriented architectures			.419	.575	.554	n/a							
	5 - Close IT/business collaboration	.864	.679	.160	.211	.218	.168	.824						
IT flexibility	6 - Integration	.897	.686	.250	.485	.297	.334	.402	.828					
	7 - Modularity	.828	.617	.200	.404	.095	.271	.216	.494	.785				
	8 - Scalability	.875	.700	.088	.156	.134	.157	.360	.319	.378	.837			
Controls	9 - Organizational size	1.000	1.000	.038	.043	.338	.109	-.032	-.132	-.085	.000	1.000		
	10 - Industry type	1.000	1.000	-.106	-.006	-.050	.021	-.076	-.009	-.097	-.148	-.145	1.000	
	11 - Strategic IT/ business alignment	.931	.819	.180	.099	.125	.116	.591	.352	.267	.327	.147	-.144	.905

Table 1. Construct reliability and validity (square root of AVE highlighted)

Besides evaluating the reflective measurement models, we also assessed the quality of our two formative measurement models, which belong to two of the first-order constructs of SOA (i.e., service-oriented technology architecture and fit of service-oriented architectures). As reported in Table 2, in each of the two formative measurement models, which both consist of five items, all but one weight are significant at $p \leq .05$. However, we kept all indicators based on the results of an exploratory factor analysis as both contribute to the completeness of the formatively measured constructs.

Further, we assessed a possible inflation due to multicollinearity: Analyzing the variance inflation factors (VIFs) shows that these vary between 1.507 and 1.998 for service-oriented technology and between 2.566 and 4.207 for fit of service-oriented architectures (cf. Table 2), which is acceptable according to the common suggestions of 3.33 or 10 as maximally acceptable VIFs (Cenfetelli and Bassellier 2009; Gefen et al. 2011). Thus, we can assume that multicollinearity is not a major issue.

Construct	Label	VIFs	Weights
Service-oriented technology architecture	SOT1	1.822	.380**
	SOT2	1.998	.299*
	SOT3	1.565	.303**
	SOT4	1.525	.281**
	SOT5	1.507	.113
Fit of service-oriented architectures	FSA1	2.566	.305**
	FSA2	3.989	.162*
	FSA3	3.020	.166*
	FSA4	4.207	.452**
	FSA5	3.354	.032

Table 2. VIFs and weights of formative instruments

An evaluation of the path coefficients between the first-order and second-order constructs shows that all of them are highly significant $p \leq .01$ and range from .155 to .429 (SOA, formed by its first-order constructs) and from .666 to .859 (IT flexibility, reflected by its first order constructs).

This provides further evidence that indeed all four aspects of service orientation are important parts of SOA, which is manifested at all layers of the enterprise architecture. IT flexibility was operationalized in a reflective way by its first-order constructs (as common in the literature) because otherwise the R-square of IT flexibility would not have been interpretable (for the moderation test it is indispensable to calculate R-square based on the theoretical determinants, separately from the own first-order factors).

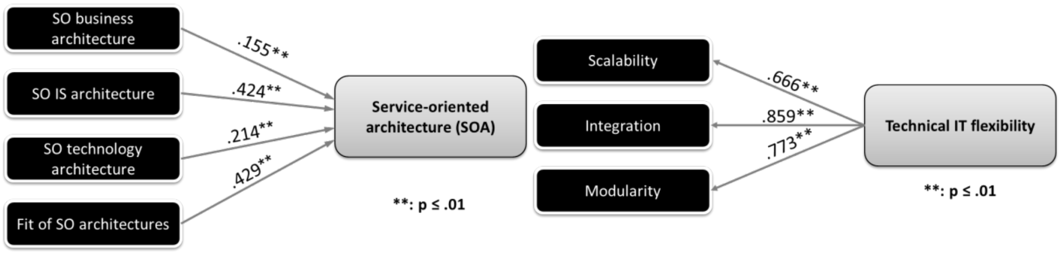

Figure 2. Relationship between first-order and second-order constructs

Lastly, we conducted two tests to investigate whether *common method variance* had biased our results. First, using Harman's single factor test, an exploratory factor analysis extracted as a single largest factor a component which explains only 29.5% but not the majority of the variance. Second, we used a theoretically unrelated marker variable[58] serving as proxy for a common method factor (Podsakoff et al. 2003). To test for the influence of the common method factor on our results, we linked the marker variable to all dependent latent variables, which allows for partialling out common method effects. The results of the model with and without the common method factor do not show any structural differences: No significance level of any path changed and the largest absolute change in path coefficients is .008; further, all R^2 values remain unaffected (the largest delta is .001). These results give us confidence that common method bias is not a serious problem in our data and thus does not serve as rival explanation.

In summary, all tests regarding data quality and measurement validity and reliability support the view that we have a solid foundation in order to evaluate the structural model in the following.

3.3 Test of Direct Relationships

First, we assesses the impact of the direct effects (H1 to H3) before we go into detailed assessment of the mediator (H4) versus moderator (H5) role of close IT/business collaboration for explaining SOA's impact on IT flexibility. All results are visualized in Figure 4 at the end of this section.

Table 3 shows that SOA has a strong, positive and highly significant impact on technical IT flexibility (H1 confirmed; $\beta = .387$; $p \leq .01$). Further, SOA shows a moderate, positive and highly significant impact on close IT/business collaboration (H2 confirmed; $\beta = .235$; $p \leq .01$). In addition, the results reveal that close IT/business collaboration weakly and significantly increases IT flexibility (H3 confirmed; $\beta = .167$; $p \leq .05$).

Analyzing the impact of the control variables shows a negative impact of the size of an organization (i.e., measured in the total number of employees) on IT flexibility ($\beta = -.203$; $p \leq .01$) while industry type does not have an effect. By contrast, strategic IT/business alignment has a very

[58] "IT should facilitate access to new markets and regions." rated on a 7-Likert scale from "no goal" to "most important goal".

strong and significant impact on IT flexibility ($\beta = .279$; $p \leq .01$). Comparing the R-squares of a PLS model containing only the control variables with a complete model including SOA, shows that the R-square of technical IT flexibility increases by 18.7 points (from 19.8% to 38.5%).

Impact of ...		*on ...*	
		Close IT/business collaboration	**Technical IT flexibility**
H1, H2	SOA(β)	**.235****	**.387****
H3	Close IT/business collaboration		**.167***
Control variables	Organizational size (β)		**-.203****
	Industry type (β):		-.064
	Strategic IT/business alignment		**.279****
	R²:		.385
	R² (only controls):		.198
Note: **: $p \leq .01$; *: $p \leq .05$, significant relationships highlighted			

Table 3. R squares (R^2) and path coefficients (β) of the direct effects

The corresponding effect sizes (f^2) of adding SOA or close IT/business collaboration to the model further emphasize the moderate importance of SOA for explaining IT flexibility ($f^2 = .22$), a weak importance of SOA for explaining close IT/business collaboration ($f^2 = .06$) as well as a weak importance of close IT/business collaboration on IT flexibility ($f^2 = .03$) according to Chin (1998).

3.4 Mediation Test

After evaluating the structural model with respect to the basic direct relationships, we tested whether close IT/business collaboration mediates the relationship between SOA and technical IT flexibility. Therefore, we estimated the path from SOA to IT flexibility in a reduced PLS model without close IT/business collaboration. In this second model, the path coefficient increases from .387 to .415, which implies that a small indirect effect exists. Following Baron and Kenny (1986), we evaluated our mediation hypotheses using Sobel's z-test (Shrout and Bolger 2002) revealing a z-value of 1.478, which would only be significant at $p \leq .1$. The strength of the indirect effect can be assessed using the variance accounted for (VAF) (Shrout and Bolger 2002), which is .09 in this case and thus rather weak.

However, Hayes argues that "we should not be using tests that assume normality of the sampling distribution when competing tests are available that do not make this assumption and that are known to be more powerful than the Sobel test" (2009, p. 411). Preacher and Hayes (2004) and Hayes (2009) have shown that indirect effects are not always distributed symmetrically or normally and they propose an alternative approach to using the Sobel test, i.e., bootstrapping the sampling distribution. Thus, we followed Preacher and Hayes (2004) as well as Hayes (2009) and estimated the indirect effect of SOA on IT flexibility through close IT/business collaboration using a confidence interval. Both the 95% (.003 to .113) as well as the 99% confidence interval (.001 to .144) do not include zero and yield to a point estimate of .042 based on 2,000 bootstrap samples. Thus, the mediation effect is weak but H4 can be confirmed.

3.5 Moderation Test

In order to evaluate the role of close IT/business collaboration as moderator of the link from SOA to IT flexibility, we followed the two-stage approach[59] suggested by Chin et al. (2003). As we have included both formative and reflective measurement models in our research model, no alternative superior approach for assessing moderating effects is currently available (Henseler and Chin 2010).

For calculating the interaction term we used the mean-centered latent variable scores of close IT/business collaboration as well as the four first-order constructs of SOA, which led to four formative items of the interaction term (close IT/business collaboration * service-oriented business architecture; close IT/business collaboration * service-oriented IS architecture; close IT/business collaboration * service-oriented technology architecture; and close IT/business collaboration * fit of service-oriented architectures). As single indicators for the other constructs, we used the standardized latent variable scores computed during the first stage of the approach for the second stage. Only SOA was measured with four indicators (formatively) based on the standardized latent variable scores of the four first-order constructs.

Adding the moderator term to the PLS model, which consists of the latent variable scores as indicators for the constructs, increases the R^2 of IT flexibility from 38.4% to 46.9%, which corresponds to a moderate effect size (f^2) of .16, and adds further explanatory power to our model. The path coefficient from the moderator term to IT flexibility is .210 ($p \leq .01$). Figure 3 shows the interaction plot of how two different levels of close IT/business collaboration (high, which is 2 standard deviations (SD) above the mean; and low, which is 2 SD below the mean) and increasing SOA affect the level of technical IT flexibility. While the absolute values are rather uninteresting (Edwards and Lambert 2007), comparing the two slopes of the lines shows that increasing SOA leads to a slightly stronger (weaker) increase of technical IT flexibility when close IT/business collaboration is high (low).

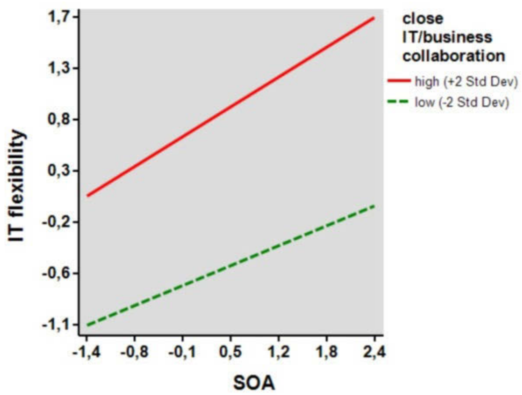

Figure 3. Effect of SOA and high (+2 SD) vs. low (-2 SD) closeness of IT/business collaboration on IT flexibility

Finally, Figure 4 summarizes all our results. Please note that the moderator path coefficient (i.e., H5: .210) represents a single effect but not a main effect.

[59] For conducting this approach we have deleted the direct path from SOA to IT/business collaboration.

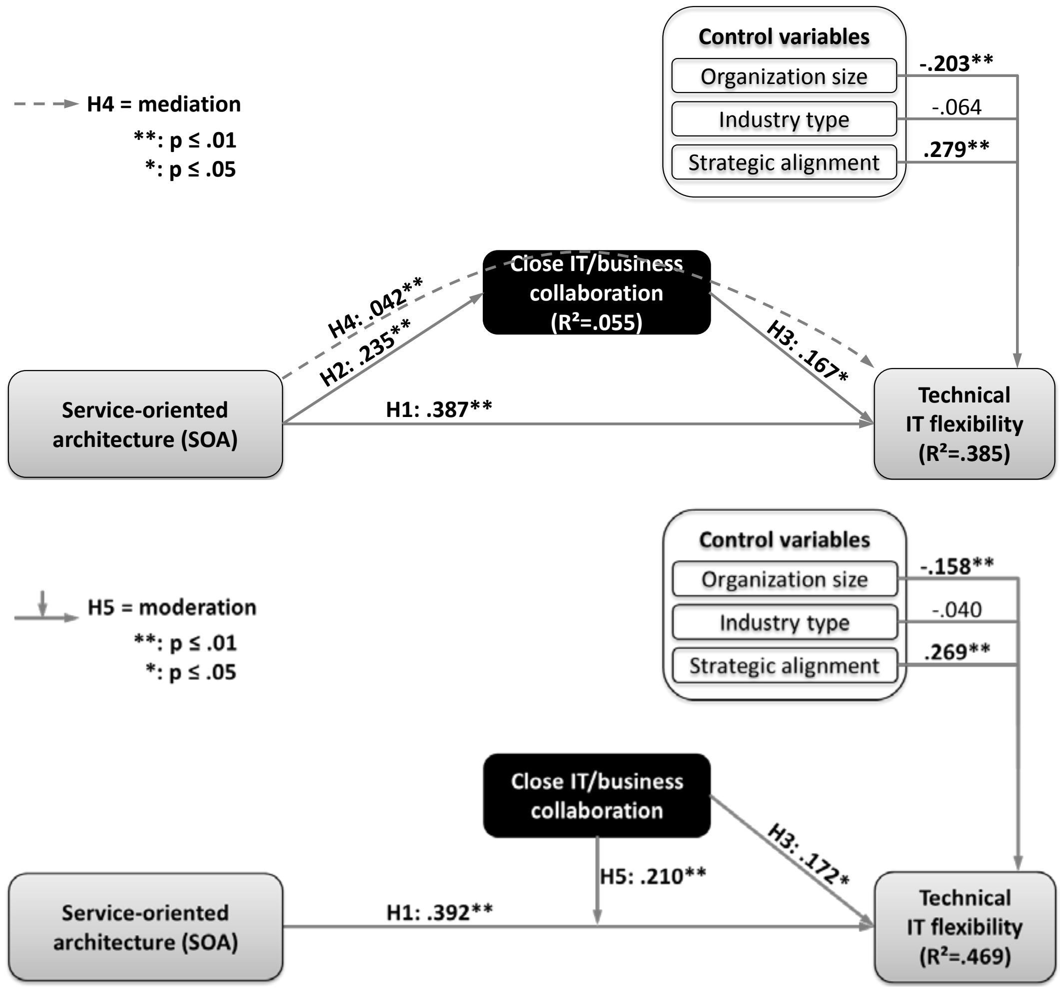

Figure 4. Results of model evaluation (top: Close IT/business collaboration as mediator; bottom: Close IT/business collaboration as moderator)

4 Discussion

First, the direct relationships (H1 to H3) are clearly supported as proposed. Thus, SOA indeed increases technical IT flexibility and it is also related with close collaboration between IT and business departments, which in turn positively impacts IT flexibility.

Second, the analysis of the role of close IT/business collaboration as mediator (H4) versus moderator (H5) provides interesting insights. Even though the literature argues that SOA might facilitate establishing a shared language and a shared understanding between IT and business departments (mediator model: service orientation serves as a shared mental model which supports close IT/business collaboration), the empirical results provide only marginal support for this argument. Thus, we can conclude that other factors are much more important – and effective – for increasing the collaboration between IT and business departments than establishing a consistent and service-oriented design of all layers of the enterprise architecture. However, SOA implementations are often driven by the IT department[60] which focuses on technologies and IS design principles – often

[60] Prior to this survey we conducted nine case studies in the German service industry and could also observe that the majority of the SOA implementations are IT driven.

without an intensive involvement of the business departments at the early stages of the SOA introduction. This rather one-sided (or non-holistic) SOA adoption approach, which clearly cannot lead to the creation of shared mental models or increased mutual understanding, could provide a possible explanation as to why close IT/business collaboration does not mediate the relationship. For example, one finding from expert interviews is that "some users also state that there has been no improvement in IT/business cooperation through the introduction of SOA; on the contrary, the already existing problems only became more obvious" (Becker et al. 2009, p. 9). Another possible explanation is that even after implementing aligned service-oriented concepts on the business and IT layer, "business people and IT people have a tendency to conceive of the concept of service differently: both groups comprehend service from their own perspectives" (Antikainen and Pekkola 2009, p. 8). Thus, instead of establishing a shared language through SOA, the communication remains dysfunctional or might even get worse because "from the business process viewpoint the service is simply a business service", while "from the technical perspective, the same service is perceived as a technical, application-level service" (Antikainen and Pekkola 2009, p. 8); thus people might believe to use services as a shared mental model, but in fact they do not, as business and technical services do not match each other. However, despite the rather weak empirical support of the mediator model, the direct relationships are highly significant. Hence, SOA itself strengthens the collaboration between IT and business, which consequently increases the technical IT flexibility.

By contrast, regarding close IT/business collaboration's role as moderator, the results support that IT/business collaboration is indeed an important factor for leveraging SOA's organizational impact. Thus, as SOA only moderately raises IT/business collaboration quality, and since IT/business collaboration is identified as important success factor for SOA, organizations should increase their collaboration prior to implementing SOA using other means (e.g., job rotations, joint workshops and trainings, or informal meetings) to establish mutual understanding and effective collaboration between IT and business departments.

While the industry type to which an organization belongs is irrelevant for our dependent variable, strategic IT/business alignment is clearly not. Better aligned IT and business strategies support a common direction for the IT development, which is in accordance with the business strategy and thus directs the flexibility of the IT towards the aspects demanded by the business. Also, the results show that larger organizations (in terms of number of employees) have a less flexible IT.

5 Conclusion

Overall, we can conclude that SOA is an effective means of achieving IT flexibility. However, we have also seen that, in contrast to the indirect effect of close IT/business collaboration, its moderating effect is quite important for organizations seeking to leverage SOA's full potential for increasing technical IT flexibility.

Thus, our empirical results call into question the argument that implementing SOA establishes a shared mental model and mutual understanding between IT and business departments. As the moderation effect is stronger, organizations should not only look at common SOA issues (like SOA governance (Joachim et al. 2011b)) and hope for better alignment following the SOA implementation. Instead they should also explicitly implement management actions that facilitate collaboration between business and IT as this further improves the outcomes of implementing SOA.

Typical examples for creating a shared understanding and improving IT/business collaboration are job rotations, joint workshops and trainings, informal meetings, etc. However, as we have not investigated the effectiveness of such mechanisms for increasing collaboration between business and IT, future research is needed to investigate which mechanisms improve IT/business collaboration and support effective utilization of SOA in an organization.

One limitation of our data is that we had to rely on the chief IT architects as single informants. While they have superior knowledge regarding their SOA and technical IT flexibility, they might not give completely unbiased answers regarding the collaboration between IT and business. Thus, having another informant (e.g., from the business side) could substantially enhance the data quality even further when repeating a similar study. Further, a larger data base would enable the application of covariance-based SEM approaches, which in turn would allow for comparative tests of complete models (such as mediation vs. moderation) in order to test for competing theories.

As the indirect effect (i.e., close IT/business collaboration as a mediator) was statistically significant but extremely weak, future research should again investigate the role of IT/business collaboration with a competing model approach to gain further insights into the role of IT/business collaboration as mediator or moderator. An excellent means of gaining more concrete answers would be to collect data at different points in time. As our analysis relies on data from a single point in time, the causality is based on the existing body of literature, but not derived from the quantitative analysis, which only identifies correlations without causality. Thus, longitudinal data would allow researchers to investigate which effect occurs first, giving much more reliable answers with respect to our research question.

Overall, we hope that our findings can inform future research on the organizational and business value of IT architectures. The effective interplay between business and IT when it comes to adapting the IT infrastructure to the organization's needs is a highly critical success factor, and those firms that have understood how to design and to align their architectural resources, will be more likely to become the champions of the future.

6 References

Antikainen, J. and Pekkola, S. 2009. "Factors influencing the alignment of SOA development with business objectives", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Armstrong, J.S. and Overton, T.S. 1977. "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research* (14:3), pp. 396–402.

Avison, D., Jones, J., Powell, P., and Wilson, D. 2004. "Using and validating the strategic alignment model", *Journal of Strategic Information Systems* (13:3), pp. 223-246.

Baron, R.M. and Kenney, D.A. 1986. "The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations", *Journal of Personality and Social Psychology* (51:6), pp. 1173–1182.

Baskerville, R., Cavallari, M., Hjort-Madsen, K., Pries-Heje, J., Sorrentino, M., and Virili, F. 2005. "Extensible architectures: The strategic value of service-oriented architecture in banking", in: *Proceedings of the 13th European Conference on Information Systems (ECIS)*. Regensburg, Germany.

Becker, A., Buxmann, P., and Widjaja, T. 2009. "Value potential and challenges of service-oriented architectures - a user and vendor perspective", in: *Proceedings of the 17th European Conference on Information Systems (ECIS)*. Verona, Italy.

Beimborn, D. and Joachim, N. 2011. "The joint impact of service-oriented architectures and business process management on business process quality: An empirical evaluation and comparison", *Information Systems and e-Business Management* (9:3), pp. 333–362.

Bieberstein, N., Bose, S., Fiammante, M., Jones, K., and Shah, R. 2005. *Service-oriented architecture (SOA) compass: Business value, planning, and enterprise roadmap*. Upper Saddle River, NJ: IBM Press.

Brown, R.H. and Karamouzis, F. 2001. "The services value chain: Forging the links of services and sourcing", *Gartner Research*.

Byrd, T.A. and Turner, D.E. 2000. "Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct", *Journal of Management Information Systems* (17:1), pp. 167–208.

Cenfetelli, R.T. and Bassellier, G. 2009. "Interpretation of formative measurement in information systems research", *MIS Quarterly* (33:4), pp. 689–707.

Chanopas, A., Krairit, D., and Khang, D.B. 2006. "Managing information technology infrastructure: A new flexibility framework", *Management Research News* (29:10), pp. 632-651.

Cherbakov, L., Galambos, G., Harishankar, R., Kalyana, S., and Rackham, G. 2005. "Impact of service orientation at the business level", *IBM Systems Journal* (44:4), pp. 653–668.

Chin, W.W. 1998. "The partial least square approach to structural equation modeling", in: *Modern methods for business research,* G.A. Marcoulides (ed.). Mahwah, NJ, USA: Lawrence Erlbaum Associates, pp. 295–336.

Chin, W.W., Marcolin, B.L., and Newsted, P.R. 2003. "A partial least squares latent variable modeling approach for measuring interaction effects: Results from a monte carlo simulation study and an electronic-mail emotion/adoption study", *Information Systems Research* (14:2), pp. 189–217.

Chung, S.H., Byrd, T.A., Lewis, B.R., and Ford, F.N. 2005. "An empirical study of the relationships between IT infrastructure flexibility, mass customization, and business performance", *SIGMIS Database* (36:3), pp. 26–44.

Chung, S.H., Rainer, R.K., and Lewis, B.R. 2003. "The impact of information technology infrastructure flexibility on strategic alignment and applications implementation", *Communications of the Association for Information Systems* (11:1), pp. 191–206.

Duncan, N.B. 1995. "Capturing flexibility of information technology infrastructure: A study of resource characteristics and their measure", *Journal of Management Information Systems* (12:2), pp. 37–57.

Edwards, J.R. and Lambert, L.S. 2007. "Methods for integrating moderation and mediation: A general analytical framework using moderated path analysis", *Psychological Methods* (12:1), pp. 1–22.

Erl, T. 2004. *Service-oriented architecture: A field guide to integrating XML and web services*. Upper Saddle River, NJ: Prentice Hall.

Feeny, D.F. and Willcocks, L.P. 1998. "Core IS capabilities for exploiting information technology", *Sloan Management Review* (39:3), pp. 9-21.

Franke, J., Wagner, H.-T., and Weitzel, T. 2005. "The role of information technology business alignment in value creation: A multiple case study among german banks", in: *Proceedings of the 26th International Conference on Information Systems (ICIS)*. Las Vegas, NV, USA, pp. 603–616.

Gable, G.G., Sedera, D., and Chan, T. 2008. "Re-conceptualizing information system success: The IS-impact measurement model", *Journal of the Association for Information Systems* (9:7), pp. 1–32.

Gefen, D., Rigdon, E.E., and Straub, D. 2011. "An update and extension to SEM guidelines for administrative and social science research", *MIS Quarterly* (35:2), pp. iii–A7.

Gefen, D., Straub, D.W., and Boudreau, M.-C. 2000. "Structural equation modeling and regression: Guidelines for research practice", *Communications of the Association for Information Systems* (4:1), pp. 1–77.

The Open Group. 2009. *TOGAF version 9*, (9 ed.). Zaltbommel: Van Haren Publishing.

Haines, M.N. and Haseman, W.D. 2009. "Service-oriented architecture adoption patterns", in: *Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA.

Hayes, A. 2009. "Beyond Baron and Kenny: Statistical mediation analysis in the new millennium", *Communication Monographs* (76:4), pp. 408–420.

Heffner, R. 2010. "Adoption of SOA: Still strong, even in hard times", *Forrester Research*.

Henningsson, S., Svensson, C., and Vallen, L. 2007. "Mastering the integration chaos following frequent M&As: IS integration with SOA technology", in: *Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS)*. Waikoloa, Big Island, HI, USA: IEEE Computer Society.

Henseler, J. and Chin, W.W. 2010. "A comparison of approaches for the analysis of interaction effects between latent variables using partial least squares path modeling", *Structural Equation Modeling: A Multidisciplinary Journal* (17:1), pp. 82–109.

Janssen, M. and Joha, A. 2008. "Emerging shared service organizations and the service-oriented enterprise: Critical management issues", *Strategic Outsourcing: An International Journal* (1:1), pp. 35–49.

Joachim, N. 2011. "A literature review of research on service-oriented architectures (SOA): Characteristics, adoption determinants, governance mechanisms, and business impact", in: *Proceedings of the 17th Americas Conference on Information Systems (AMCIS)*. Detroit, MI, USA.

Joachim, N., Beimborn, D., and Weitzel, T. 2011a. "Eine empirische Untersuchung des Wertbeitrages von serviceorientierten Architekturen (SOA)", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Joachim, N., Beimborn, D., and Weitzel, T. 2011b. "SOA-governance für effektive serviceorientierte Architekturen – Eine empirische Studie in der deutschen Dienstleistungswirtschaft", in: *Proceedings of the 10th International Conference on Business Informatics*. Zurich, Switzerland.

Krafzig, D., Banke, K., and Slama, D. 2005. *Enterprise SOA: Service-oriented architecture best practices*. Upper Saddle River, NJ: Prentice Hall.

Kumar, R.L. 2004. "A framework for assessing the business value of information technology infrastructures", *Journal of Management Information Systems* (21:2), pp. 11–32.

Kumar, S., Dakshinamoorthy, V., and Krishnan, M.S. 2007. "SOA and information sharing in supply chain: “How” information is shared matters!", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Langan-Fox, J., Anglim, J., and Wilson, J.R. 2004. "Mental models, team mental models, and performance: Process, development, and future directions.", *Human Factors and Ergonomics in Manufacturing* (14:4), pp. 331-352.

Lublinsky, B. 2007. "Defining SOA as an architectural style: Align your business model with technology". retrieved 08/11/2010, from http://www.ibm.com/developerworks/architecture/library/ar-soastyle/.

Luftman, J. and Brier, T. 1999. "Achieving and sustaining business-IT alignment", *California Management Review* (42:1), pp. 109-122.

Mathieu, J.E., Goodwin, G.F., Heffner, T.S., Salas, E., and Cannon-Bowers, J.A. 2000. "The influence of shared mental models on team process and performance", *Journal of Applied Psychology* (85:2), pp. 273–283.

Mathieu, J.E., Rapp, T.L., Maynard, M.T., and Mangos, P.M. 2010. "Interactive effects of team and task shared mental models as related to air traffic controllers' collective efficacy and effectiveness", *Human Performance* (23:1), pp. 22–40.

Meschke, M. and Baumoel, U. 2010. "Architecture concepts for value networks in the service industry", in: *Proceedings of the 31st International Conference on Information Systems (ICIS)*. St. Louis, MI, USA, pp. 1–13.

Mohammed, S., Klimoski, R., and Rentsch, J.R. 2000. "The measurement of team mental models: We have no shared schema", *Organizational Research Methods* (3:2), pp. 123-166.

Nunnally, J.C. 1978. *Psychometric theory*, (2. ed.). New York, NY: McGraw-Hill.

Oh, L.-B., Leong, Y.-X., Teo, H.-H., and Ravichandran, T. 2007. "Service-oriented architecture and organizational integration: An empirical study of IT-enabled sustained competitive advantage", in: *Proceedings of the 28th International Conference on Information Systems (ICIS)*. Montreal, QC, Canada.

Papazoglou, M.P. and Heuvel, W.-J. 2007. "Service oriented architectures: Approaches, technologies and research issues", *The VLDB Journal* (16:3), pp. 389–415.

Peterson, E., Mitchell, T.R., Thompson, L., and Burr, R. 2000. "Collective efficacy and aspects of shared mental models as predictors of performance over time in work groups", *Group Processes & Intergroup Relations* (3:3), p. 296.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. 2003. "Common method biases in behavioral research: A critical review of the literature and recommended remedies", *Journal of Applied Psychology* (88:5), pp. 879–903.

Preacher, K.J. and Hayes, A.F. 2004. "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods* (36:4), pp. 717–731.

Preston, D. and Karahanna, E. 2004. "Mechanisms for the development of shared mental models between the cio and the top management team", in: *Proceedings of the 25th International Conference on Information Systems (ICIS)*. Washington, DC, USA, pp. 465–479.

Reich, B.H. and Benbasat, I. 2000. "Factors that influence the social dimension of alignment between business and information technology objectives", *MIS Quarterly* (24:1), pp. 81-113.

Reich, B.H. and Kaarst-Brown, M.L. 2003. "Creating social and intellectual capital through IT career transitions", *Journal of Strategic Information Systems* (12:2), pp. 91-109.

Ringle, C.M., Wende, S., and Will, A. 2007. "SmartPLS 2.0 (M3) Beta". Hamburg.

Sabherwal, R. and Chan, Y.E. 2001. "Alignment between business and IS strategies: A study of prospectors, analyzers, and defenders", *Information Systems Research* (12:1), pp. 11-33.

Shrout, P. and Bolger, N. 2002. "Mediation in experimental and nonexperimental studies: New procedures and recommendations", *Psychological Methods* (7:4), pp. 422–445.

Tafti, A., Mithas, S., and Krishnan, M.S. 2008. "The effects of information technology and service-oriented architectures on joint venture value", in: *Proceedings of the 29th International Conference on Information Systems (ICIS)*. Paris, France.

Tallon, P.P. 2008. "Inside the adaptive enterprise: An information technology capabilities perspective on business process agility", *Information Technology and Management* (9:1), pp. 21–36.

Tarafdar, M. and Qrunfleh, S. 2009. "IT-business alignment: A two-level analysis", *Information Systems Management* (26:4), pp. 338-349.

Tiwana, A. 2003. "Knowledge partitioning in outsourced software development: A field study", in: *Proceedings of the 24th International Conference on Information Systems (ICIS)*. Seattle, WA, USA, pp. 259–270.

Viering, G., Legner, C., and Ahlemann, F. 2009. "The (lacking) business perspective on SOA - critical themes in SOA research", in: *Proceedings of the 9th International Conference on Business Informatics*. Vienna, Austria, pp. 45–54.

Wade, M. and Hulland, J. 2004. "Review: The resource-based view and information systems research: Review, extension, and suggestions for future research", *MIS Quarterly* (28:1), pp. 107-142.

Winter, R. and Fischer, R. 2007. "Essential layers, artifacts, and dependencies of enterprise architecture", *Journal of Enterprise Architecture* (3:2), pp. 1–12.

Yoon, T. and Carter, P.E. 2007. "Investigating the antecedents and benefits of SOA implementation: A multi-case study approach", in: *Proceedings of the 13th Americas Conference on Information Systems (AMCIS)*. Keystone, CO, USA, pp. 1–11.

7 Appendix

Construct (Source)	Label	Indicator (Scales: "fully disagree" to "fully agree" (5- or 7-step Likert scale); other scales are described) *(translated from German)*	Skew-ness	Kur-tosis	Loadings (Weights)
Service-oriented business architecture	SOB1	We follow a service-oriented perspective when modeling business activities.	.072	-1.101	.955**
	SOB2	Services are the primary concept for structuring the non-technical level.	.071	-1.247	.955**
Service-oriented IS architecture	SOI1	Our firm has realized its IT architecture in an SOA-oriented manner.	.497	-.816	.947**
	SOI2	Our IT landscape follows the SOA paradigm as far as possible.	.344	-1.206	.949**
	SOI3	Service orientation is the primary design principle of our IT architecture.	.466	-1.025	.924**
	SOI4	All of our applications are integrated via service-oriented interfaces.	.543	-.700	.913**
Service-oriented technology architecture (Kumar et al. 2007; Oh et al. 2007)		To what extent are the following technologies used in your organization?			
	SOT1	XML	-.080	-.443	(.380**)
	SOT2	Web Services (WSDL, SOAP)	.223	-.891	(.299*)
	SOT3	Enterprise service bus (ESB) or other service-related bus	1.284	.290	(.303**)
	SOT4	Registry / repository	1.378	.758	(.281**)
	SOT5	Business process execution language (BPEL)	2.340	4.552	(.113)
		Scale: 0 = {not known| not applied}core ; 1 = pilot usage; 2 = single projects; 3 = particular business area; 4 = multiple business areas; 5 = firm wide			
Fit of service-oriented architectures		To what extent are the following processes supported by SOA?			
	FSA1	production/operations	1.221	.558	(.305**)
	FSA2	procurement/B2B integration	1.570	1.820	(.162*)
	FSA3	research & development	1.947	3.214	(.166*)
	FSA4	marketing/sales/customer relations	1.379	1.007	(.452**)
	FSA5	secondary processes (accounting, HR etc.)	1.762	2.399	(.032)
		Scale: 5-Likert scale from "no SOA" to "solely supported by SOA"			
Modularity (Chung et al. 2005; Tallon 2008)	MOD1	We can add new functionality to our systems without having serious problems.	-.661	-.329	.780**
	MOD2	Exchanging or modifying single components does not affect our IT infrastructure.	-.377	-.696	.816**
	MOD3	Our systems consist of clearly separated modules.	-.206	-1.076	.759**
Integration (Byrd and Turner 2000; Chanopas et al. 2006)	ITG1	Exchanging data between different systems is very easy.	-.391	-.462	.854**
	ITG2	Data of one system can be easily used in other systems.	-.417	-.422	.883**
	ITG3	We can easily create consolidated views about all data belonging to a customer.	-.038	-.914	.820**
	ITG4	We can integrate additional data formats (e. g. EDI, XML) easily in our applications.	-.341	-.681	.751**
Scalability (Chanopas et al. 2006; Gable et al. 2008)	SCA1	Our IT infrastructure can easily compensate peaks in transaction volumes.	-.815	-.023	.814**
	SCA2	Our IT infrastructure offers sufficient capacity in order to fulfill additional orders.	-1.059	.803	.880**
	SCA3	The performance of our IT infrastructure completely fulfills our business needs.	-.810	.276	.815**
Close IT/business collaboration (Byrd and Turner 2000; Chung et al. 2003)	IBC1	IT and business units work closely together in projects and daily operations.	-.553	-.169	.805**
	IBC2	IS development projects are performed in close collaboration between IT and business units.	-.493	-.479	.872**
	IBC3	Change requests are prioritized in close collaboration between IT and business units.	-.369	-.421	.794**
Organizational size	OSI	Logarithm of total number of employees. (source: secondary data)			
Industry type	INT	3 dummy variables: logistics & trade, financial services, and IT & communication (source: secondary data)			
Strategic IT/business alignment (Chung et al. 2003)	SAB1	The IT strategy is accurately aligned with the business strategy.	-.721	.258	.927**
	SAB2	The IT investments are accurately aligned with the business objectives.	-.814	.763	.871**
	SAB3	The business strategy is effectively supported by the IT strategy.	-.858	.562	.916**
Note: significance levels of loadings/weights: **: $p \leq .01$, *: $p \leq .05$					

Table 4. Indicators used in the measurement model

Concept	Construct (first-order)	Indi-cator	1	2	3	4	5	6	7	8	9	10	11
SOA	1 - Service-oriented business architecture	SOB1	.955	.585	.306	.395	.170	.216	.128	.039	.045	-.069	.146
		SOB2	.955	.551	.378	.406	.136	.262	.253	.129	.028	-.133	.199
	2 - Service-oriented IS architecture	SOI1	.503	.947	.506	.540	.173	.495	.381	.201	.069	.006	.095
		SOI2	.579	.949	.514	.531	.236	.411	.398	.200	.023	-.017	.093
		SOI3	.613	.924	.483	.564	.224	.415	.335	.120	.081	-.076	.122
		SOI4	.523	.913	.459	.512	.152	.493	.395	.058	-.016	.068	.060
	3 - Service-oriented technology architecture[1]	SOT1	.222	.441	.758	.391	.217	.416	.141	.098	.208	-.106	.120
		SOT2	.337	.434	.805	.404	.217	.289	.099	.163	.276	-.010	.141
		SOT3	.174	.358	.757	.513	.154	.144	.011	.099	.379	-.047	.122
		SOT4	.360	.324	.637	.329	.072	.035	.060	.078	.112	.008	-.017
		SOT5	.174	.259	.562	.333	.031	-.010	-.073	-.030	.266	.043	.042
	4 - Fit of service-oriented architectures[1]	FSA1	.396	.518	.477	.870	.194	.281	.223	.173	.106	-.011	.155
		FSA2	.336	.522	.450	.894	.159	.312	.223	.157	-.005	.044	.108
		FSA3	.352	.438	.466	.840	.145	.243	.310	.131	.032	.058	.045
		FSA4	.388	.544	.552	.943	.122	.328	.238	.124	.162	.006	.092
		FSA5	.339	.470	.319	.806	.120	.307	.248	.026	-.022	.133	.057
	5 - Close IT/business collaboration	IBC1	.079	.097	.096	.123	.805	.248	.060	.251	-.033	-.144	.414
		IBC2	.146	.233	.150	.148	.872	.360	.298	.309	-.094	.012	.595
		IBC3	.153	.161	.272	.139	.794	.360	.125	.318	.055	-.093	.420
IT flexibility	6 - Integration	ITG1	.128	.337	.216	.249	.385	.854	.408	.273	-.070	.004	.301
		ITG2	.216	.407	.244	.302	.384	.883	.437	.256	-.165	.021	.397
		ITG3	.209	.384	.205	.282	.275	.820	.368	.324	-.190	-.106	.253
		ITG4	.286	.490	.326	.275	.283	.751	.425	.199	.000	.055	.204
	7 - Modularity	MOD1	.182	.386	.268	.271	.198	.453	.780	.393	.002	-.128	.250
		MOD2	.115	.232	-.060	.175	.163	.395	.816	.292	-.127	-.066	.133
		MOD3	.175	.331	-.019	.180	.142	.294	.759	.177	-.087	-.019	.252
	8 - Scalability	SCA1	.027	.142	.091	.135	.289	.231	.372	.814	.031	-.081	.220
		SCA2	.044	.123	.056	.068	.245	.220	.314	.880	-.007	-.146	.243
		SCA3	.145	.127	.185	.187	.364	.343	.265	.815	-.022	-.144	.351
Controls	9 - Org. size	OSI	.038	.043	.338	.109	-.032	-.132	-.085	.000	1.000	-.145	.147
	10 - Industry type	INT	-.106	-.006	-.050	.021	-.076	-.009	-.097	-.148	-.145	1.000	-.144
	11 - Strategic IT/ business alignment	SAB1	.169	.097	.166	.143	.552	.303	.231	.321	.210	-.174	.927
		SAB2	.093	.025	.091	.018	.508	.281	.251	.264	.121	-.140	.871
		SAB3	.218	.139	.083	.144	.543	.367	.244	.300	.073	-.083	.916

Note: [1] Also the cross-loadings of the two first-order constructs, which were formatively measured, are reported.

Table 5. Cross-Loadings of Indicators on First-Order Constructs

Appendix

Publications

Refereed Journals

Joachim, Nils; Beimborn, Daniel; Weitzel, Tim (2013) (**Paper VII**):

The Influence of SOA Governance Mechanisms on IT Flexibility and Service Reuse

In: Journal of Strategic Information Systems (JSIS) (forthcoming 2013)

Beimborn, Daniel; Joachim, Nils; Weitzel, Tim (2012) (**Paper VI**):

Do Service-Oriented IT Architectures facilitate Business Process Outsourcing? A Study in the German Service Industry

In: Zeitschrift für Betriebswirtschaft (ZfB), Journal of Business Economics, (82:Special Issue 4), pp. 77-108

Beimborn, Daniel; Joachim, Nils (2011) (**Paper V**):

The Joint Impact of Service-Oriented Architectures and Business Process Management on Business Process Quality: An Empirical Evaluation and Comparison

In: Information Systems and e-Business Management (ISeB), (9:3), pp. 333-362

Refereed Conferences

Joachim, Nils; Beimborn, Daniel; Weitzel, Tim (2011) (**Paper IV**):

An Instrument for Measuring SOA Maturity

In: Proceedings of the 32nd International Conference on Information Systems (ICIS), Shanghai, China

Joachim, Nils; Beimborn, Daniel; Schlosser, Frank; Weitzel, Tim (2011) (**Paper VIII**):

Does SOA Create or Require IT/Business Collaboration? Investigating SOA's Potential to Reduce the Gap Between IT and Business

In: Proceedings of the 32nd International Conference on Information Systems (ICIS), Shanghai, China

Joachim, Nils; Beimborn, Daniel (2011):

Exploring SOA´s Potential for Business Process Outsourcing

In: Proceedings of the 11th International Conference on Electronic Business (ICEB), Bangkok, Thailand

Joachim, Nils (2011) (**Paper I**):
A Literature Review of Research on Service-Oriented Architectures (SOA): Characteristics, Adoption Determinants, Governance Mechanisms, and Business Impact
In: Proceedings of the 17th Americas Conference on Information Systems (AMCIS), Detroit, MI, USA

Beimborn, Daniel; Joachim, Nils; Weitzel, Tim (2011):
Do Service-Oriented IT Architectures facilitate Business Process Outsourcing? A Study in the German Service Industry
73rd VHB Annual Congress (73. Wissenschaftliche Jahrestagung des Verbandes der Hochschullehrer für Betriebswirtschaft (VHB)), Kaiserslautern, Germany

Joachim, Nils; Beimborn, Daniel; Weitzel, Tim (2011):
SOA-Governance für effektive serviceorientierte Architekturen - Eine empirische Studie in der deutschen Dienstleistungswirtschaft
In: Proceedings of the 10th International Conference on Business Informatics (WI), Zurich, Switzerland

Joachim, Nils; Beimborn, Daniel; Weitzel, Tim (2011):
Eine empirische Untersuchung des Wertbeitrages von serviceorientierten Architekturen (SOA)
In: Proceedings of the 10th International Conference on Business Informatics (WI), Zurich, Switzerland

Beimborn, Daniel; Joachim, Nils; Schlosser, Frank; Wagner, Heinz-Theo; Weitzel, Tim (2011):
Die Bedeutung relationaler Faktoren für den IT-Wertbeitrag - Eine Studie unter den größten 1.500 US-Banken
In: Proceedings of the 10th International Conference on Business Informatics (WI), Zurich, Switzerland

Joachim, Nils; Beimborn, Daniel; Weitzel, Tim (2011):
What Are Important Governance and Management Mechanisms to Achieve IT Flexibility in Service-Oriented Architectures (SOA)? An Empirical Exploration
In: Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS), Koloa, HI, USA

Joachim, Nils (2009):
Service-Oriented Architectures (SOA): An Empirical Investigation of Adoption Determinants and Resulting Business Value
Doctoral Consortium of the 30th International Conference on Information Systems (ICIS), Phoenix, AZ, USA

Beimborn, Daniel; Joachim, Nils; Schlosser, Frank; Streicher, Björn (2009):
The Role of IT/Business Alignment for Achieving SOA Business Value - Proposing a Research Model
In: Proceedings of the 15th Americas Conference on Information Systems (AMCIS), San Francisco, CA, USA

Münstermann, Björn; Joachim, Nils; Beimborn, Daniel (2009):
An empirical evaluation of the impact of process standardization on process performance and flexibility
In: Proceedings of the 15th Americas Conference on Information Systems (AMCIS), San Francisco, CA, USA

Beimborn, Daniel; Joachim, Nils, Münstermann, Björn (2009):
Impact of Service-oriented Architectures (SOA) on Business Process Standardization – Proposing a Research Model
In: Proceedings of the 17th European Conference on Information Systems (ECIS), Verona, Italy

Beimborn, Daniel; Gleisner, Fabian; Joachim, Nils; Hackethal, Andreas (2009):
The Role of Process Standardization in Achieving IT Business Value
In: Proceedings of the 42nd Hawaii International Conference on System Sciences (HICSS), Waikoloa, HI, USA

Beimborn, Daniel; Joachim, Nils; Weitzel, Tim (2008):
Drivers and Inhibitors of SOA Business Value - Conceptualizing a Research Model
In: Proceedings of the 14th Americas Conference on Information Systems (AMCIS), Toronto, ON, Canada

Refereed Workshops

Beimborn, Daniel; Joachim, Nils; Schlosser, Frank (2011):
The Role of SOA for BPO Intention - Proposing a Research Model
In: Sharman, Raj; Rao, H. Raghav; Raghu, T. S. (Eds.): Exploring the Grand Challenges for Next Generation E-Business: 8th Workshop on E-Business, WEB 2009, Phoenix, AZ, USA, December 15, 2009, Lecture Notes in Business Information Processing (LNBIP), Springer, Berlin, pp. 122-136

Joachim, Nils; Beimborn, Daniel; Weitzel, Tim (2010):
Why do Firms Adopt Service-Oriented Architectures? A Conceptualization and Evaluation of SOA Adoption
MIS Quarterly Prospective Authors (Pre-ICIS) Workshop, St. Louis, MO, USA

Joachim, Nils; Beimborn, Daniel; Weitzel, Tim (2010):
Investigating Adoption Determinants of Service-oriented Architectures (SOA)
AIS Special Interest Group on Services (SIG SVC) (Pre-ICIS) Workshop, St. Louis, MO, USA

Joachim, Nils; Beimborn, Daniel; Hoberg, Patrick; Schlosser, Frank (2009):
Examining the Organizational Decision to Adopt Service-Oriented Architecture (SOA) - Development of a Research Model
Special Interest Group on Adoption and Diffusion of Information Technology (DIGIT) (Pre-ICIS) Workshop, Phoenix, AZ, USA

Beimborn, Daniel; Joachim, Nils (2009):
Proposing the Relationship between IT Business Alignment and the Business Value of Service-Oriented Architectures in Financial Firms
In Kundisch, Dennis; Veith, Daniel J.; Weitzel, Tim; Weinhardt, Christof (Eds.): Enterprise Applications and Services in the Finance Industry, Lecture Notes in Business Information Processing (LNBIP), Springer, Berlin, pp. 78-93

Beimborn, Daniel; Joachim, Nils (2008):
How to Achieve Business Value of SOA? - Investigating the Relationships between SOA, IT Business Alignment and Sourcing Strategies
AIS Special Interest Group on Services (SIG SVC) (Pre-ICIS) Workshop, Paris, France

Beimborn, Daniel; Joachim, Nils; Schlosser, Frank; Weitzel, Tim (2008):
A Social Linkage View on the Business Value of IT
JAIS Theory Development Workshop (Pre-ICIS) Workshop, Paris, France

Beimborn, Daniel; Joachim, Nils; Weitzel, Tim (2007):
Proposing an Instrument for Evaluating the Business Value of Service-Oriented Architectures
3rd International Workshop on Enterprise Applications and Services in the Finance Industry (Pre-ICIS) Workshop, Montreal, QC, Canada

Non-Refereed Research Report

Weitzel, Tim; König, Wolfgang; Beimborn, Daniel; Joachim, Nils; Schlosser, Frank (2010):
Die Bedeutung Serviceorientierter Architekturen für den Unternehmenserfolg: Eine wissenschaftliche Erhebung in der deutschen Dienstleistungswirtschaft
Research Report, E-Finance Lab at Goethe University in Frankfurt and University of Bamberg