

THE (LACKING) BUSINESS PERSPECTIVE ON SOA – CRITICAL THEMES IN SOA RESEARCH

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Abstract

Service-oriented architecture (SOA) has gained much popularity lately, in both practice and academia. Since SOA concepts and technology are maturing, companies have started to engage in projects that will fundamentally transform IS landscapes over the next decade. While the growing body of SOA research is mostly technology-oriented, there is a need to review the current state of research in light of the strategic, organizational, and managerial issues associated with SOA implementation. This paper profiles SOA and Web services research since 2000 with a focus on practices, adoption, and impact. Drawing on a sample of 175 papers in academic journals and conference proceedings, we establish transparency of the current state of SOA research. Our analysis finds that the science base for SOA research from an IS perspective is still under construction thereby reflecting the novelty of the underlying technologies. We conclude that business aspects remain underserved and derive a number of recommendations for the IS community on how to proceed with SOA research.

1. Introduction

Since the term service-oriented architecture was originally coined by Gartner analysts in 1996 [32], it has gained much popularity in both practice and academia. Owing to the hype around Web service technologies and the subsequent announcements of software vendors, such as SAP, IBM, and others to incorporate Web services and SOA in their product suites, the service-oriented paradigm has been revitalized in the early 2000s. In the meantime, researchers have started to explore how loosely coupled services can be combined and rearranged in order to flexibly support the needs of end-users within and across organizations. They have come up with a large variety of SOA scenarios and prototypes. At the same time, a scientific discourse has been initiated, resulting in debates among renowned researchers [9, 26, 45, 47], literature reviews [23, 28, 36] or propositions for research agendas [36]. This discourse contributes to defining the service-oriented paradigm and analyzing its specificities compared to prior concepts, notably software components or object orientation. While our scientific understanding of SOA is improving and technology is maturing, a more detailed analysis of the management-related questions associated with SOA design, adoption, and impact in practice is still lacking. Taking into consideration that 63% of all North-American, European, and Asian-Pacific companies are already using SOA, or will start using it by the end of 2008 [17], there is a need for an academic discussion on the manifold strategic, organizational and managerial issues related to it. Given the sheer volume of SOA research, it seemed obvious that a surveying of the literature could assist in identifying and aggregating the different perspectives in this field of research. Drawing on a sample of 175 articles in peer-reviewed journals and conference proceedings, this article investigates the current state of research. To this aim, we use a research framework that is based on generic IS research questions and focuses on SOA adoption, practices,

and impact. Our analysis delineates several areas that remain underserved and that offer researchers the opportunity to contribute to the development of the field of SOA research. Consequently, we aim at establishing a science base for future research.

The paper is organized as followed: part 2 provides an overview of the methodology and the framework of analysis. This is followed by the results section of the literature review. From the discussion of the results, we derive several areas that remain underserved. Finally, a summary and conclusion is provided that also discusses the limitations of this study.

2. Framework of Analysis and Methodology

2.1 The SOA Discourse: Framework of Analysis

Through a literature review, the exposure of theoretical foundations in an emerging issue like the field of SOA can be tackled and areas where research is needed are uncovered [49]. Recognizing the suggestions of Webster & Watson [49] and Fettke [11], a literature review framework is helpful in guiding the literature analysis. We develop such a framework of analysis by deriving four general SOA research questions based on Gregor's taxonomy of theory types in information systems [14] (c.f. Figure 1):

- *What are the characteristics of the SOA paradigm?*
This research question aims at analyzing and describing the phenomena of interest. In addition to their definitions, the fundamental constructs (artifacts) that characterize SOA as an architectural paradigm and their relationships are of particular relevance. The *what is* question often results in Theory for Analyzing (Type I) according to the taxonomy suggested by Gregor [14]. It is seen as the most basic type of theory as it provides the realist ontology required for further research.
- *How – and to what extent – are SOA concepts adopted in practice?*
There are many IS innovations that – due to technical, cultural or economic factors – have not made their way to broader implementation in practice. In this regard, it is of interest for researchers to analyze adoption and diffusion of SOA concepts in and between organizations. This will ultimately lead to insights into adoption patterns and the factors that determine successful SOA implementations. It will also explain the emerging web services offerings and market mechanisms. Answering this research question requires researchers to conduct empirical studies and to collect observations from the field. It typically results in Theories for Explaining (type II) [14].
- *How to design, implement, and manage SOAs?*
This research question aims at specifying how organizations should apply the SOA concept, and might be most valuable from the practitioner's point of view. It is associated with a constructivist type of research or design science, resulting in frameworks, reference models, methods, and management practices. Gregor [14] classifies this type of theory as Theory for Design and Action.
- *What is the organizational impact of SOA?*
While most computer scientists agree that the service-oriented paradigm has clear benefits in terms of technical quality attributes, it has been difficult to economically justify SOA. Researchers consequently need to come up with approaches and methodologies for describing and measuring the impact of SOA. Given the multiple facets of SOA, technical as well as economic and strategic impacts of SOA concepts need to be considered. Consequently, research will most likely produce Theories for Explaining and Predicting [14], with testable propositions and causal explanations.

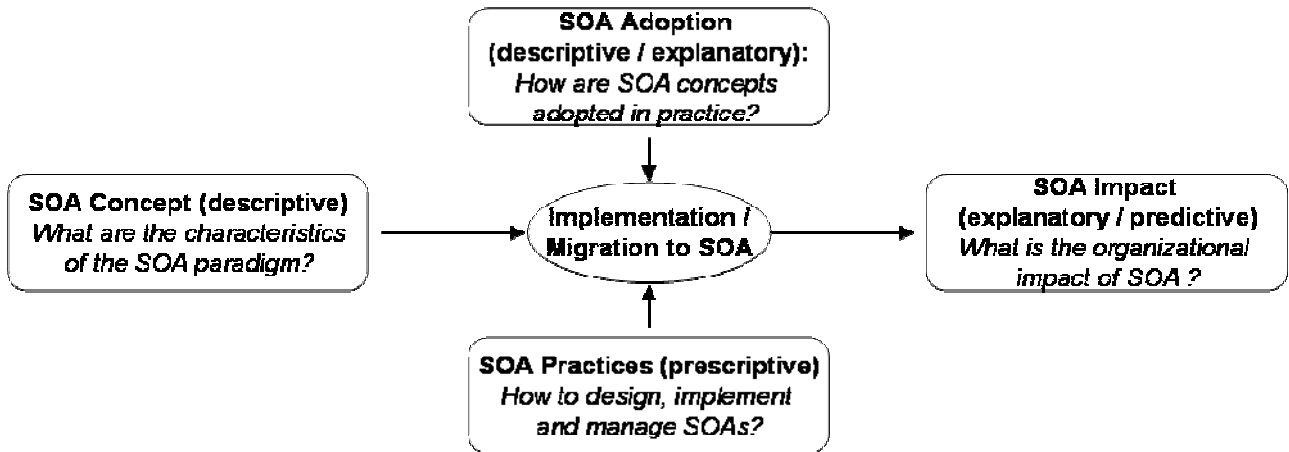


Figure 1: Framework of Analysis

2.2 Literature Selection Process

As the basis of our literature review, we relied on the AIS Meta Ranking [38] which has a wide acceptance among researchers as an international journal meta-ranking which combines different scientific approaches. A set of key words (“SOA”, “service-oriented”, “web services”, “component-based”, “CORBA”, and “architecture”) was used in a first step to identify journals, which were further investigated. Following Webster and Watson’s suggestion [49], we then checked the journals’ tables of content from January 1990 to December 2007 in order to identify articles on SOA and web services. Since our focus is on SOA adoption, practices and impact in organizations, we excluded articles from the computer science domain that solely focus on the technical concepts that underlie SOA. For this paper, only articles containing the term SOA and/or web service in the title or abstract were taken into account. Articles that appeared in 2008 and papers from IS conferences were also included in the analysis. Since our analysis was targeted at reviewing the current state of research, we did not include publications that are not peer-reviewed, such as monographies.

2.3 Review and Classification Process

During the review and classification process, we analyzed and coded the selected publications by focusing on the following three aspects: the general publication data, including sub-codes for the year of publication, the publication type (conference or journal), and the primary focus (SOA or web services). Then, the research methodology where we relied on the taxonomy developed by Wilde and Hess [50]. In order to cover literature reviews, we added *literature analysis* which has been suggested by Palvia et al. [35]. Classification of the research methodology and the general publication data was performed “top-down” [42] by one author and checked by another author. In the third step, we analyzed and coded the content according to the framework of analysis presented in section 2.1. We developed the coding scheme for the content using Weber’s eight necessary steps of *Creating and Testing a Coding Scheme* [48]. For the assignment to one of the four key research questions, classification was based on the stated research objectives of the paper. For Weber’s first necessary step, we defined the recording unit as the sentence. Next, we identified categories by using an initial open test coding [12] on a sample of 28 randomly selected articles. The results of this initial phase were discussed among the authors and classified to one of the four research questions of the reference frame resulting in the first sub-codes. Then, two rounds of axial coding [46] were performed by two authors in a step-wise manner on the complete set of data. If none of the initial codes were suitable, new sub-codes were added. In the third step, we tested for inter-rater reliability by comparing the results of the two rounds. Differing views between the two coders were discussed until agreement was reached. All resulting categories were critically assessed and singular cases were selectively reassigned to a different key research question. In a third

iteration, each paper was assigned to a final category. In some cases, multiple research objectives were pursued, which led to the assignment of a secondary classification. The derivation of research opportunities was based on a careful comparison of our framework's analysis dimensions with the literature found.

3. Results

3.1 Overview

From the tables of contents of 37 journals that we checked, we identified 175 articles within the scope of our analysis. Approximately two thirds of all articles refer rather to the specific technology of Web services (#112) than to SOA (#63). Only a small portion was covering both key words (#9). However, as the run of the curve of the following graph indicates, increasingly more scientific papers about SOA than about Web services are being published for the last 2 years. We interpret this as an indicator that the research community found consensus on the distinction of the two terms. Furthermore, we see a constant increase of publications in this research topic while press releases in mid-2007 claimed that the SOA hype is over [29]. Scientific publications seem to reflect the increase of research objects from the field as SOA diffuses among companies. In addition, a very active scientific debate has started with special issues in high ranked journals, such as the Journal of Management Information Systems (announced for 2009), International Journal of Electronic Commerce (announced for 2009), and Wirtschaftsinformatik (1/2008).

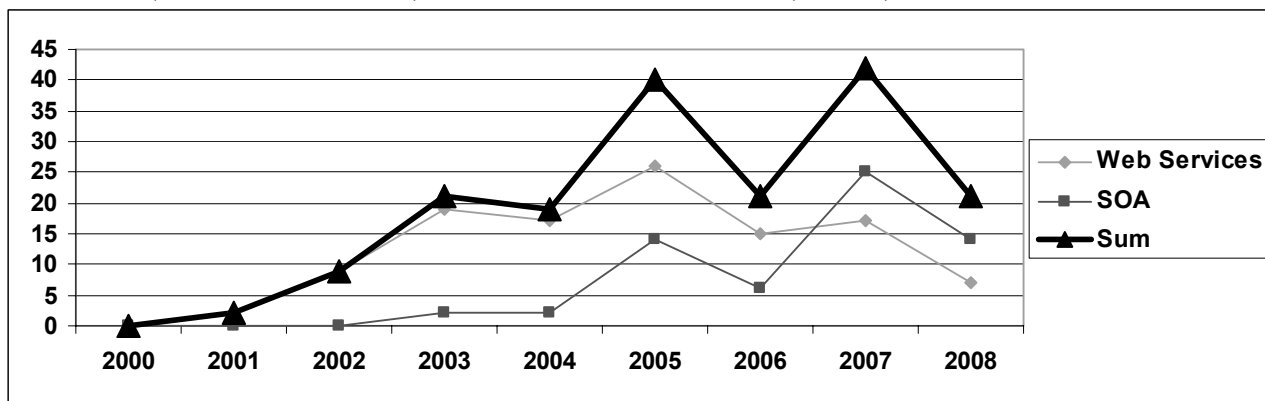


Figure 2: SOA and Web Services Publications by Year of Publication

3.2 Content Classification

On the level of the four research questions, most articles proposed suggestions on how to design, implement, and manage SOAs (#86/49%) followed by papers analyzing the adoption (#37/21%) and investigating the phenomena of SOA and Web services (#31/18%). With 11%, only a minor portion of the publications analyze the impact of SOA and Web services in practice. The analysis of the sub-codes identified during the review and classification process, provides us with some further insights into the current state of research: With regard to the first research question “*What are the characteristics of the SOA paradigm?*”, the majority of the papers (#18/10%) investigate the primary SOA and Web services artifacts and discuss standards. This category is followed by 10 papers (6%) that aim at defining SOA or Web services or contribute to aggregating various definitions. The sub-category *SOA Products* relates to presentations and critical evaluations of SOA suites of vendors. We identified only few papers which describe products from three large software vendors namely IBM [10], Microsoft [40] and SAP [53]. Publications on the second area of research (“*How are SOA and web services adopted in practice?*”) comprise case descriptions which are either teaching cases [13] or case documentations of SOA implementations in practice. Besides case descriptions (#13/7%), the sub-category *Assimilation / Adoption* is most prominent with also

13% of all publications. For the third research question (“*How to design, implement, and manage SOAs?*”), the analysis clearly illustrates that it has attracted the most interest from the research community (#86/49%). Together, the following four sub-categories represent 91% of all the papers in this area of research: Publications that suggest *enhancements of SOA and Web services concepts* are the topic of 29 papers (17%), while 23 papers (13%) investigate *domain-specific architecture designs*. 14 papers (8%) provide suggestions and practices for *service management*, and 12 publications suggest methods *for implementing SOA or designing services*. The smallest fraction of papers focuses on the fourth research question “*What is the economic impact of SOA and web services?*” With ten papers, the largest sub-category in this field (#10/6%) comprises publications investigating the benefits of web services and SOA. The second largest category includes six papers that are focusing on methodologies to measure the impact and the actual impact measurement (#6/3%).

Content Classification according to the Areas of SOA Research	Frequencies (primary classification)		Frequencies (incl. multiple classifications)	
	#	%	#	%
<i>1. SOA Concepts: What are the characteristics of the SOA paradigm?</i>	31	18%	38	18%
Artifacts and Standards	18	10%	22	11%
Definitions	10	6%	11	5%
Products	3	2%	5	2%
<i>2. SOA Adoption: How are SOA and web services adopted in practice?</i>	37	21%	50	24%
Cases	13	7%	17	8%
Assimilation / Adoption	13	7%	21	10%
Success and Influence Factors	3	2%	3	1%
IT Infrastructure	2	1%	3	1%
Service Management	3	2%	3	1%
Web Service Offerings and Markets	3	2%	3	1%
<i>3. SOA Practices: How to design, implement, and manage SOAs?</i>	86	49%	92	45%
Architecture Design with SOA/WS (Enhancements and Extensions)	29	17%	29	14%
Architecture Design with SOA/WS (Domain Specific)	23	13%	26	13%
Implementation Methods	12	7%	14	7%
Organization and Governance	4	2%	5	2%
Reference Models	4	2%	4	2%
Service Management	14	8%	14	7%
<i>4. SOA Impact: What is the organizational impact of SOA?</i>	19	11%	24	12%
Benefits	10	6%	15	7%
Impact Measurement / Methodologies	6	3%	6	3%
IT Infrastructure	1	1%	1	0%
ROI	2	1%	2	1%
<i>not assignable</i>	2	1%	2	1%
Total	175	100%	206	100%

Table 1: Content classification according to the Framework of Analysis

3.3 Analysis of Research Methods

Our analysis reveals that all methods from Wilde and Hess’s spectrum of IS research methods [50] were classified at least once, except ethnography and Grounded Theory. The undisputed majority of researchers are using a conceptual-deductive research method (#75/43%), thus relying upon the authors’ experience, observation, or thought, followed by papers arguing deductively (#32/18%). Case studies were the preferred choice for empirical analysis (#24/14%). Large-scale empirical studies using *surveys* or *qualitative and quantitative cross-section analysis* were scarce. It is important to note that a combination of several methods was frequently applied. As an example, concep-

tual models were tested by the means of *Prototypes, Laboratory and Field Experiments*, consequently following a design science approach [18] with evaluation cycles.

Research Methodology	Frequencies (primary classifica- tion)		Frequencies (multiple classifications)	
	#	%	#	%
Action Research	2	1%	2	1%
Argumentative Deductive Research	32	18%	32	15%
Case Study	24	14%	26	12%
Formal Deductive Research	8	5%	9	4%
Conceptional Deductive Research	75	43%	77	35%
Laboratory / Field Experiment	4	2%	19	9%
Literature Analysis	10	6%	10	5%
Prototyping	0	0%	18	8%
Qualitative/ Quantitative Cross- Sectional Analysis	9	5%	11	5%
Reference Modeling	6	3%	6	3%
Simulation	1	1%	3	1%
<i>not assignable</i>	4	2%	4	2%
<i>Total</i>	<i>175</i>	<i>100%</i>	<i>217</i>	<i>100%</i>

Table 2: Classification according to Research Methods Employed

4. Discussion of Findings – Current State of Research and Research Challenges

4.1 SOA Concepts: What are the Characteristics of the SOA Paradigm?

Most authors refer to the core Web services standards http, XML, SOAP, and WSDL and the W3C architecture when defining Web services [21]. While there is consensus on Web services definitions, the understanding of SOA is still under discussion. Several authors take a “historical” perspective and argue that SOA extends well-known concepts, notably software componentization and object-orientation [4, 44, 45]. At the same time, services are said to differ from components or objects, e.g. in terms of granularity and interface-orientation [7]. An increasing number of publications refer to SOA as an architectural style, which builds on services as key artifacts [2, 8, 20, 25, 33]. However, opinions differ more widely when it comes to the design principles that characterize SOA as an architectural style. The key challenge here is the lack of consistency between authors with respect to terminology, emphasis, and the levels of abstraction used to organize the design principles. Furthermore, most publications do not relate SOA to prior (enterprise) architecture conceptualizations. Among the early attempts is the architecture model by Legner and Heutschi [27], which extends an existing enterprise architecture model by specifying SOA artifacts at the IS architecture layer. In order to cover the business perspective, future research needs to explore how SOA alters prior enterprise architecture conceptualizations and architecture frameworks. Given the versatility of the SOA concept, it is recommended that future research complements the generic SOA definitions with taxonomies and typologies that characterize service and SOA designs.

4.2 SOA Adoption: How are SOA and Web Services Adopted in Practice?

To date, SOA adoption in practice has mainly been studied based on case studies from real-world implementations. Some industries, notably the financial industry, are much more present in these studies than others [1, 2]. While case studies allow researchers to gain valuable insights into SOA adoption, their findings still lack a broader empirical validation. A small group of researchers has started to investigate business, methodical, and technical factors that influence SOA and Web services implementation success [1]. Another stream of research explores SOA adoption by means of

the diffusion of innovation theory. Xu et al. [51] and Haines [16] derive models for measuring the assimilation of SOA from prevailing innovations theories. The resulting frameworks suggest different levels of adoption and are to be validated as broader empirical studies. The studies of SOA adoption at the organizational level are complemented by research on emerging third-party service offerings and market opportunities for service providers. Initial work has been performed with regard to classifying the evolving Web service offerings and their business and pricing models [34]. Given the early stage of research in this area, multiple research opportunities exist. The existing case study research needs to be complemented by conceptual frameworks that build on prior IS theories. In view of the versatility of the service-oriented paradigm and the differences between industries, it is necessary to particularly investigate the contingencies that exist with regard to SOA adoption. Ideally, this research would identify SOA adoption patterns and success factors. With regard to the market for Web services, there is a need to further explore the specificities of (web) service offerings compared to other types of digital goods.

4.3 SOA Practices: How to Design, Implement, and Manage SOAs?

Our literature review indicates a concentration of research in this area. When it comes to the implementation in practice, most authors emphasize that Web service standards and SOA frameworks do not yet fully address real-world requirements. As demonstrated by our analysis, a tremendous effort has been undertaken to explore and enhance the design of SOAs and Web services environments, resulting in two types of research contributions: (1) conceptual approaches for extending and enhancing the existing architecture models, and (2) the design of SOAs and Web services environments for specific domains. The first type of research contributions comprises various conceptualizations to enable dynamic Web services composition in order to flexibly support business processes within and across organizations. Among the suggested concepts are Web-services based workflows [5, 24], matching mechanisms [22], and context-aware Web services [30]. Additionally, a very active research community develops semantic descriptions of standard Web services with the help of WSDL-S, ontologies, etc. [3, 41, 52]. With a different focus, the second stream of research comes up with reference architectures or architecture designs for specific domains. Our analysis finds that e-Commerce, supply chain management, knowledge and document management as well as ubiquitous and mobile computing are amongst the most popular domains for SOA implementations. The results achieved in terms of architecture models are impressive and show various benefits that SOA and Web services may bring to the business world. However, a key challenge for future research consists in the analysis of differences and commonalities and the assessment of different SOA and service designs. This calls for a debate on how the quality of SOA designs can be assessed and measured. Consequently, a necessity for widely accepted criteria for the business design of services and reference scenarios arises, as in the case of the Semantic Web Contest, which might provide a valuable input to this debate. With regard to the future design of SOA, the emerging discipline of service engineering offers a number of research opportunities. First, design principles and methodologies for service design need to be further enhanced and validated in order to cover functional as well as non-functional aspects. Second, researchers need to come up with service design proposals for specific domains. While most of the existing research still focuses on the design of SOA-based information systems, many scholars emphasize that service management imposes major challenges for organizations. IT departments that have traditionally been organized around applications will be forced to adapt to completely new management practices. Papazoglou and Van den Heuvel [37] suggest a comprehensive service life-cycle methodology. Other researchers focus on specific aspects, such as the visualization tools for service management [6]. Therefore, an interesting opportunity for future research relates to the implications of the service-oriented paradigm for the strategic IT management in organizations, both in terms of roles and in terms of governance.

4.4 SOA Impact: What is the Organizational Impact of SOA and Web services?

The existing work on SOA impact can be categorized in two streams of research: The first one aims at explaining SOA impact by developing models that explain the business impact of SOA. As an example, Huang integrated web services with competitive strategies using a balanced scorecard approach [19], whereas Müller et al. [31] suggest causal links between SOA design principles and SOA benefits. The second stream of research identifies SOA benefits. This comprises visionary papers [15] as well as or studies of benefits in specific scenarios, for example customer relationship management [43] or small and medium-sized enterprises [39]. From the literature review, two main limitations in the current state of research were identified: first, there is still no model for analyzing the economic rationale for SOA based on prior IS theories. In this regard, the current debate on SOA's business impact fails to pick up on earlier IS research on the effectiveness and value of IS. Second, the existing studies have investigated SOA benefits based on single or multiple case studies. They have identified a great variety of benefits of SOA implementations that range from infrastructure to operational, organizational, and strategic benefits. However, their findings have neither been systematically consolidated into a framework nor validated by means of a broader empirical basis. Future SOA research needs to apply and extend prior IS theories and systematically study how SOA improves the capabilities of an organization which in turn creates business value.

Field of Research	State of Discussion	Future Research Challenges
1. SOA Concept: What are the characteristics of the SOA paradigm?	• SOA as architectural style characterized by artifacts and design principles • Web services as the promising SOA implementation technology	• SOA in the context of enterprise architectures • SOA and service taxonomies / classifications
2. SOA Adoption: How are SOA and web services adopted?	• SOA case studies • Innovation theory for explaining SOA adoption	• Conceptual models explaining SOA adoption • Success factors based on empirical studies
3. SOA Practice: How to design, implement, and manage SOAs?	• Extensions and enhancements of SOA (process composition, semantics, ...) • SOA design for specific domains • Service life-cycle management	• Assessment criteria for SOA and service design • Domain-specific SOA design • Methodologies for service engineering • SOA in the context of strategic IT management
4. SOA Impact: What is the organizational impact of SOA?	• Exploration of SOA benefits based on case studies • Several lines of argumentation for explaining SOA business impact	• Benefit frameworks covering strategic, operational and technical dimensions • Models explaining the economic rationale for SOA based on prior IS theories

Table 3: SOA research – Status and Future Research Challenges

4. Summary and Conclusions

This paper profiles the existing SOA and Web services research based on four generic research questions. Our analysis of 175 publications has shown that SOA and Web services research has significantly developed since 2000. Nevertheless, the literature analysis also illustrates the early stage of research in this field, since most publications focus on either enhancing SOA and Web service concepts or exploring their adoption in practice. Interestingly, few publications address the remaining two fundamental research questions, namely the characteristics of the SOA paradigm and the organizational impact of SOA. However, “analytic theory is necessary for the development of all the other types of theory” [14]. This need for clarifying the fundamental definitions related to our phenomena of interest might also explain the difficulties in further exploring its adoption as well as assessing the quality of SOA and service designs. Most importantly, we conclude that business aspects are still underserved by SOA research. This generates future research opportunities related to the four research questions: in order to better understand and describe the role of SOA in

organizations, IS researchers need to relate SOA to the broader context of the enterprise architecture. With regard to SOA adoption, the existing case study research has to be complemented by conceptual frameworks that build on prior IS theories for explaining SOA adoption and success factors. The future design of SOAs calls for more research in the field of service engineering, covering non-functional aspects as well as domain-specific business logic. From the perspective of strategic IT management, more research is needed to explore the implications of SOA, particularly related to roles and governance. In order to further understand the impact of SOA, researchers need to further investigate how SOA investments improve a firm's capabilities and thereby create business value. While our study provides interesting insights into the current state of SOA research, it is important to mention the limitations: First, the focus of our literature analysis has been peer-reviewed journal and selected conference publications. While this ensures the quality of the publications, it excludes valuable contributions that have been presented at workshops or are currently in the review process for journal publication. Second, we limited our scope to SOA and Web services, thereby excluding predecessors of SOA, notably CORBA. Third, the field of SOA and Web services is extremely dynamic with a strong increase in publications over the last three years. Consequently, our research presents a mere snapshot of the SOA field.

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