

Service Oriented Computing in Practice – An Agenda for Research into the Factors Influencing the Organizational Adoption of Service Oriented Architectures

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Abstract

The paradigm of service-oriented computing (SOC) has emerged as an approach to provide flexibility and agility, not just in systems development but also in business process management. This modular approach to defining business flows as technology independent services has gained unanimous popularity among end-users and technology vendors alike. Although there is a significant amount of ongoing research on the potential of service oriented architectures (SOAs), there is a paucity of research literature on the factors affecting the adoption of service-oriented computing in practice. This paper reviews the current state of the technology, identifies the factors influencing the decision to adopt service-oriented computing as an enterprise strategy and discusses the associated research literature, and concludes with a suggested research agenda and conceptual framework for investigating the use of service-oriented computing in practice.

Key words: Service-Oriented Architectures, SOA, Service-Oriented Computing, SOC, Web Services, Organizational Impacts, Technology Adoption, Technology Diffusion

1 Introduction

Recent surveys of global cross-industry CEOs [32], [33], indicate that organizational agility is high on the priority list of business executives looking to establish a competitive advantage. According to these studies, executives are transforming their business models by integrating business and technology resources to create adaptable business processes for agility.

This is easier said than done. Organizations in today's business world are complex multi-faceted entities, transcending geographic boundaries. They are no longer single-platform, location specific infrastructures. Companies have acquired a myriad of technologies and infrastructures as a result of the ever-changing technology landscape, and more significantly through normal business growth – i.e., acquisition of other business entities or resources [13]. A key facet of the transformations facing global corporations today revolves around the reorganization of disparate information resources as independent, reusable services [73], moving away from viewing corporations as a building block of processes and re-inventing the corporation to be more a collection of services focused on comparative advantage [28], [53]. The automation of these services creates new kinds of business models, facilitating an integrated process across the enterprise ecosystem to include partners, suppliers, and customers [73].

The paradigm of Service Oriented Computing views whole business functions (order placement, for example) as modular, standards-based software services. The associated Service Oriented Architecture (SOA) establishes a defined relationship between such services offering discrete business functions and the consumers of these services, independent of the underlying technology implementation [57]. There is a great deal of enthusiasm in the industry about this concept but the adoption of SOA by end-user organizations is still in a relatively early stage [64]. Therefore, there is a scarcity of critical research addressing the practical challenges of adopting SOA as an enterprise strategy.

Although some literature exists on the potential impacts of service-oriented computing on organizational structure and culture [8], [27] and some empirical studies measuring the strategic benefits of specific implementations are emerging [4], [51], there is little or no realistic data available on what, if anything, firms are doing in practice to address the inherent challenges of implementing a service-oriented architecture and of aligning the enterprise along a consistent service-based approach through the business value chain – both internally across business units, and externally from suppliers or service providers to customers.

This paper outlines the various aspects of SOA adoption from a technical and business viewpoint, discusses the research efforts in these areas, highlights the dearth of critical research into the business and organizational factors influencing the adoption of SOA, and discusses potential approaches to study these factors and their impact. In doing so, this paper sets an agenda for researchers interested in the practical ramifications of the popular architectural approach to systems development and business process transformation.

The following section provides a brief background on the concept of service-oriented computing. Section 3 covers a discussion of the potential challenges beyond technology in the road to an enterprise SOA rollout, summarizing the state of affairs in current published literature and highlighting the need for empirical investigation of SOA in practice. Section 4 outlines a research agenda for studying the real-world impacts of SOA adoption discussing possible areas of investigation and potential approaches for research. The final section, Section 5, summarizes the analysis and provides some concluding remarks on future research.

2 Service Oriented Computing

As organizations have evolved with ever-changing technology, and natural organic and acquisition-based growth, the complexity of their infrastructures have increased dramatically, requiring more innovative distributed computing techniques to address their needs [13]. With the increasing diversity of platforms, protocols, and development environments over the years, the need for a higher level of abstraction was recognized as being imperative for the efficient use of existing heterogeneous and/or geographically distributed resources [12]. This need was compounded by the growing business needs for communications across diverse domains – for example, across partner or customer systems - for increased business value through strategic partnerships [18]. This gave rise to the concept of services, functional entities whose location and implementation are abstracted from the client or user, to allow the integration and communication of diverse and distributed technology domains.

The paradigm of abstracting programmatic functionality, thus, evolved from locally invoked subroutines, to remotely invoked functions (RPCs), to the object-oriented and component based standards CORBA and DCOM [2], and finally into a wider interpretation of modularity taking advantage of the growing influence of the now-ubiquitous Internet [85]. The underlying principles of service-based computing, hence, are not new concepts, but more of an evolving set of generally accepted good practices of systems development. What the current model of service oriented computing does is attempt to bring to bear these generally accepted good practices on the use of existing and emerging technologies to address the challenges of today's large scale diverse systems – i.e., "to operate efficiently and

achieve coherence in the face of component autonomy and heterogeneity” [31] – with strong industry and vendor support for standardization and associated development tools [64], [80].

2.1 What Constitutes A Service?

There are various definitions of a service within the context of Service Oriented Computing in the literature [2] and it would be prudent to review these definitions in order to highlight the significant attributes of what comprises a service. In reviewing content on the Internet, especially on industry analyst or research sites dedicated to service architectures or to defining terms, the following definitions were found. A service is a system function that is “well-defined, self-contained, and does not depend on the context or state of other services” (Site 1). It is also defined as “a unit of work to be performed on behalf of some computing entity, such as a human user or another program” (Site 2).

In formal academic literature, a service is defined as a business function implemented in software, wrapped with a formal documented interface that is well known and known where to be found not only by agents who designed the service but also by agents who do not know about how the service has been designed and yet want to access and use it [57]. These services could be simple services performing basic granular functions such as order tracking or composite services that assemble simple or other composite services to accomplish a modular business task such as a specialized product billing application.

As an example, a business flow, such as an online book retail service, could be built using services across multiple service providers pulling together, say, billing services from a partner, and warehousing services from another partner. At a lower level, this could also potentially work for an individual business application, say, the ordering of a book being built from tying together simple services such as a book search feature and customer verification.

In summary, the salient features of a service that can be inferred from the available definitions are that services:

- modular - granular in scope and execute a discrete business function (simple or complex)
- loosely coupled - hide the implementation from the service user, encapsulating the implementation
- technology neutral – are universally usable by any requester
- location transparent - are easily discoverable and identifiable, and are accessible over a network

2.2 Service Oriented Architecture (SOA)

While services manifest business functionality in the service-based computing model, a Service-Oriented Architecture (SOA) provides a framework for an infrastructure to facilitate the interactions and communications between services [57]. SOAs can be thought of as both an architecture and a programming model, more a way of thinking about building software than a software development technique [13].

Service oriented architectures put services into a framework that, independent of the underlying technologies, requires service providers to advertise their services with associated service-level agreements (SLAs) in registries that can be discovered, accessed, and used by clients [5]. It is essentially a distributed system framework [26] that stresses that all services have a network-addressable interface (easily locatable) and communicate via standard protocols and data formats called messages (easily accessible). This requirement helps resources advertise their capabilities through standard interfaces defined as part of their service definitions.

There are, consequently, three kinds of participants in a service-based architecture as depicted in Figure 1 - service providers, service requesters or clients, and the discovery agencies that help clients find services based on published criteria [57]. Service providers register or publish their service descriptions in one or more service registries or discovery agencies well-known across the network [3], [22]. These registries are the equivalent of directories for business applications, allowing businesses to publish their array of services, and allowing clients to search for available services and programmatically invoke them [81]. This service description includes a listing of its attributes - its capabilities, its location, and its interface requirements among others [25]. Service requesters query the registry using a wide variety of search criteria, including category-based searches, to find the service they need. Having identified the service, determined the interface requirements (port, protocol, and data format) and location (IP address or URL) of the service – i.e., after they discover the service – they bind to the service to invoke it. This process flow of publish-discover-bind forms the basic service management capabilities of an SOA [57].

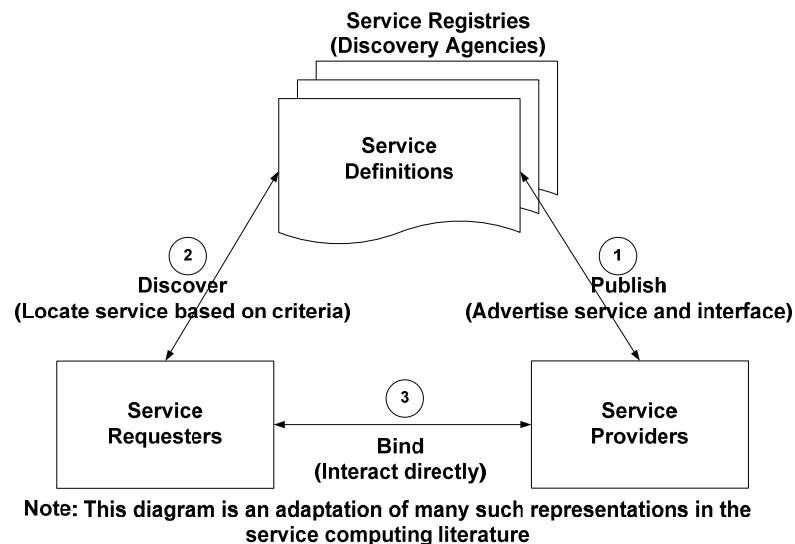


Figure 1: A Service Oriented Architecture

An SOA can therefore be viewed as an interconnected set of services which in its basic form is a message-based interaction between software agents, each accessible through standard interfaces and messaging protocols. These agents can be service providers or service requesters (clients) interacting with service discovery agencies [57]. The services in the SOA should be technology neutral, loosely coupled (not tightly integrated into the requester's process), and support location transparency.

2.3 The Basic SOA Infrastructure

Since service oriented infrastructures are essentially complex distributed computing frameworks compared to the traditional client-server approach, they require a functionality-rich supporting middleware infrastructure. The middleware requirements for SOC are viewed as an architectural layer that can provide interoperability between services using standards-based communication adapters and interfaces [59]. This middleware infrastructure is referred to as an Enterprise Service Bus (ESB).

The term ESB was originally coined by Gartner to introduce an enterprise integration technology that used industry-standard specifications such as SOAP or JMS (Java Message Service) to create loosely coupled architectures based on interfaces and flexible programming requirements [40]. According to Schmidt et al, an ESB enables an SOA by providing the connectivity layer between services, managing the meta-data describing available services [70]. Although it provides the infrastructure for inter-connecting services, an ESB does not include the business logic of the service providers or requesting applications.

A breakdown of what is a comprehensive array of ESB services and what comprise the absolute basic ESB services is explained rather well by Rick Robinson (IBM) in his three part online article available on the IBM website [67]. The following description of the core functionality of an ESB borrows from Part 1 of his article. Although the capabilities of an ESB could include a wide variety of value added functionality, at its core it should be an "open and implementation independent service messaging and interfacing model, that should isolate application code from the specifics of routing services and transport protocols, and allow service implementations to be substituted". The minimum capabilities needed to establish an ESB are:

- Communication capabilities
 - Routing and addressing services to provide location transparency
 - Service administration capability
 - At least one form of messaging
 - Support for at least one widely available transport protocol
- Integration capabilities
 - Support for means of integration to various adaptors – asynchronous messaging, J2EE connectors, etc.

The publish-bind-discover model of SOA and the ESB middleware infrastructure to enable it form the core of a basic service oriented infrastructure upon which other architectural layers can then be built to deliver enterprise solutions [57].

2.4 Taking SOA to the Enterprise Level

Papazoglou [57] introduces the concept of the Extended Service Oriented Architecture (ESOA), a layered architecture taking into account all the necessary systems engineering elements for an enterprise service-based solution. The ESOA is conceptualized as a pyramid of architectural layers consisting of the Basic Services layer, the Composite Services layer, and finally the Managed Services layer. The services from the basic layer are pulled together to form business applications. This aggregation of services is called service composition. The composition layer provides value added functionality like workflow, monitoring, and consolidated non-functional attributes such as performance, security, transactional integrity, and reliability. Built on top of this layer is the management functionality required for the integrity of the system, enforcing service level agreements.

The ESOA lays the groundwork for the practical implementation of service-based enterprise systems and for future research in service-oriented computing. This approach is detailed further by Papazoglou et al in a broad research roadmap for SOA [59] in which the authors identify the state of current research and describe the challenges for future research work, the goal being to provide a comprehensive manifesto to unify disparate international research efforts.

Specifically, the roadmap details the following four areas – (i) Service foundations – the fundamental infrastructure that implements the connectivity of heterogeneous components; (ii) Service Composition – the aggregation of services into a single composite service, addressing control and data flow, and transaction integrity; (iii) Service Management and Monitoring – the myriad of activities required to control and monitor SOA applications and infrastructures from troubleshooting to auditing, and includes systems engineering attributes like scalability, performance, and availability; and (iv) Service Design and Development – tying the design and development of services to the business process, a key facet that can fully realize the benefits of adopting SOA as a business strategy. Owing to the richness of detail of this work and the depth of research ongoing in the technical aspects of SOA, the research road map is mentioned at a high level in this paper but is not detailed further. Suffice it to say that the roadmap provides a cornerstone for further research into how service oriented computing at the enterprise level may be used from the conceptual business domain all the way to the physical implementation.

2.5 Technology Implementations of SOA

From a practical perspective, there have been varying technology implementations of the abstraction principles promoted by service-oriented computing. Each of these continue to be viable options to build distributed systems in support of flexible business applications [3].

Hub-centric message driven systems used by enterprises today are widely viewed as precursors to what is now called SOA [27]. Message oriented middleware (MOM) allowed systems to build modules that communicated over a messaging infrastructure, forming a loosely coupled system. The messaging paradigm allowed for some level of substitution of modules without requiring a change in the communication with the users of the module. Hence, it is fair to say that messaging infrastructures were an early form of SOA. Component based software programming models, such as DCOM, CORBA, and Enterprise Java Beans (EJB), are also earlier attempts at building loosely-coupled object-based systems [2], [44], [77]. All of these system models are viable options of implementing SOA in certain situations [5]. When it comes to wider use across organizational boundaries, however, the use of these models are hampered by the lack of uniform standards and support from major software vendors [11].

The next step on the implementation chain was made possible by the ubiquitous information channel - the Internet. The proliferation of technology platforms and diverse application content alongside the ease of access and availability of cheap bandwidth make the Internet an ideal inter-enterprise integration platform [81]. This has led to the emergence of Web services as the popular implementation of service-oriented concepts using the Internet and associated open standards [39] as the communication medium [11], [82].

The World-wide Web Consortium [84] formally defines a Web service as “a software system designed to support interoperable machine-to-machine interaction over a network”. The interface to a Web service is described in a machine-processable format, specifically Web Services Definition Language or WSDL. Other systems interact with the Web service using SOAP [83] messages (typically XML over HTTP) in conjunction with other Web-related standards. Web services typically have the following characteristics [2]:

- They are independent of the underlying transport protocol
- The service attributes (location, capabilities, and access mechanism) are described in the XML-based WSDL

- Web services use the directory services standard Universal Description, Discovery, and Integration (UDDI) to facilitate discovery and use by clients, and
- They use XML over HTTP (SOAP) to communicate with each other

Although Web services have been characterized as old technology in a new implementation (distributed RPCs) or even broadly as middleware [82], Web services are essentially the deployment of a service-based computing model over the Internet [11], [81], and unlike other earlier technology implementations leverage open Internet standards to facilitate diverse inter-enterprise communication [57] and has garnered relatively unanimous industry vendor support [44].

2.6 SOA in the Industry

As early as 2003, a report by Gartner [55] predicted that over time lack of SOA will become a competitive disadvantage for most enterprises. "Evolving tools, skills and best practices will make development of SOA-style applications easier than development of monolithic applications. This change will shift the massive software industry mainstream into the new software-engineering reality".

The major technology vendors appear to have invested significant effort in promoting SOA, building supporting products and tools, and even publishing related research. IBM appears to be the leader in collaborative research in this area. Its research initiative (Service Science, Engineering, and Management or SSME for short) is a collaborative effort with various universities worldwide to promote multi-disciplinary research in service-oriented computing. HP has recently introduced the Business Technology Optimization (BTO) for SOA, a set of software and services for service management. Microsoft and BEA are also updating their product suites and infrastructures to include service-oriented concepts. In addition to specific products and solutions, software vendors, large and small, have thrown their support behind SOA, working on various cross-vendor initiatives to promote the growth of SOA adoption. The efforts are too numerous to list here, but the various online trade journals have an abundance of information on vendor products, and ongoing collaboration efforts across various vendors to promote standards and interoperability for enterprise service infrastructures.

When it comes to adoption of SOA in the industry today, there are a variety of statistics available from various trade magazines and technology analysts, all generally indicating the adoption of SOA as widespread. Surveys of professionals worldwide [19], [62], [64], indicate that knowledge and awareness of SOA amongst the IT professional community is "significant", with most companies "doing something related to SOA". The associated reports conclude that the spread of SOA is "almost inevitable". This mirrors the general optimism in trade journals and magazines, indicating that SOA, and specifically Web Services, is the popular choice for businesses looking for flexible systems development.

2.7 The Business Opportunity

It is important to note that the definitions of a service covered in this discussion so far do not indicate the nature of the service – i.e., if it is a technical service (providing functionality similar to the concept of subroutines or more appropriately objects) or if it is a business service (executing a discrete business task such as processing a quote for a widget). The perspective of the service consumer is the key to understanding what comprises a service [61].

Business users may view a service as a unit of transaction described in a contract and fulfilled by a business infrastructure, whereas technology providers may view a service as a unit of functionality with an interface for access [61]. These views are not necessarily contradictory if the technical infrastructure is architected to provide composed business services on demand. A business-focused service-oriented architecture, maps business functions to technical implementations facilitating the automation of business rules, thus creating a convergence of the business and IT perspectives [73].

In other words, service oriented architectures in the business world should be viewed as application architectures "within which all functions are defined as independent services with well-defined invocable interfaces, which can be called in defined sequences to form business processes" [13]. Decomposing this definition, services can represent simple business capabilities (e.g., address validation), complex business transactions built from simple business capabilities (e.g., placing purchase orders), or broader system functions (e.g., user authentication). In addition to this essential attribute of granularity, services are "independent" in that they meet the requested need but their internal implementations are irrelevant to the business process. Arguably, the most significant advantage of a service-based business model is that these services have interfaces that are "invokable". This means that the service is reachable independent of whether they are implemented within the boundaries of the business process, or in another process either within the organization or in an external domain, be that a partner or customer environment. The attribute of being accessible independent of location is the enabler of what we have seen thus far to be the main strategic transformation facing corporations today – extending the enterprise to establish strategic partnerships [86].

The business opportunity created by SOA revolves around the reorganization of enterprise information resources as independent, reusable services [73], moving away from viewing corporations as a building block of processes, and re-inventing the corporation to be more a collection of services focused on comparative advantage [28], [53]. The automation of these services creates a new kind of business model, facilitating an integrated process across the enterprise ecosystem to include partners, suppliers, and customers [73]. However, even as SOA is now widely recognized as having the potential to improve the responsiveness of both business and IT organizations, it seems that most organizations that are adopting SOA do not fully understand the business potential of SOA, focusing on technical implementation issues instead of the broader business service view [73].

From a pragmatic perspective, there is widespread recognition of the fact that when the rubber meets the road, so to speak, various organizational issues need to be addressed for the successful implementation of any information technology [43]. What is needed beyond the SOA research roadmap, hence, is a manifesto for the further study of the real-world adoption of SOA across the enterprise and the factors that aid or impede such adoptions.

3 Factors That Could Influence Organizational Adoption of SOA – A Literature Review

Summarizing the preceding sections, SOA appears to provide many benefits as a business strategy, and is being adopted widely. So what does this really mean in practice?

Despite the sound theoretical underpinnings and general popularity of this concept, there is little academic research examining how service-oriented computing is really performing in industry. Research in the area of information technology diffusion indicates that the successful adoption of new technology requires organizations to take an integrated approach to organizational and technical changes effected by the technology [42]. The technical aspects of SOA appear to have appropriate research efforts and guidelines [31], but there is a lack of similar structure for the examination of the pragmatic impacts of the adoption of SOA. It may be prudent, therefore, to examine the possible impacts on the organization, both of the adoption and ongoing management of the service oriented approach.

Drawing upon a review of existing related literature in technology adoption and diffusion [16], [17], [21], [23], [42], [54], the factors influencing the adoption of and the impacts of the adoption of SOA may be understood by examining the role of

1. the perceived value of SOA to the organization,
2. the organizational strategy,
3. organizational context or culture,
4. organizational structure,
5. potential implementation challenges, and
6. given the current environment of increasingly stringent regulations and accountability requirements, the governance or the management of such technology [50].

The following sub-sections discuss these potential areas of impact, associated research studies, and potential topics of research within these areas. The discussion is then summarized in Table 1.

3.1 Perceived Value to the Organization

Existing literature appears to indicate, as indicated in the following sub-sections, that SOAs can potentially offer corporations increased business value and the opportunity to realize process efficiencies and lower costs, while mitigating the overall change and technology related risks of the corporation. Given the abundance of vendor and analyst reports, and the scarcity of empirical research, no attempt has been made to comment on the claims of the value of SOA, but to articulate them as the potential benefits being discussed in existing literature.

3.1.1 Business Efficiencies

Additional revenue streams: In addition to improving the existing business models, service based architectures provide a framework for corporations to offer their core competencies as services to other companies [28], [30], [79], focusing on areas of comparative advantage while buying or leasing services in which they lack superior expertise from other service providers [18]. Organizations can focus on the efficient orchestration of services to form a product and shed the burden of owning resources.

Strong strategic partnerships: The transformation of an enterprise's business processes to services, along with standards-based communication protocols, opens up new avenues of strategic partnerships with suppliers, partners, and customers. This causes the emergence of a new business model – a re-bundling of intra-and inter-enterprise business processes as seamless services [28].

3.1.2 Process efficiencies

Visibility into business flows: Existing architecture frameworks tend to be program-centric with business flow or process knowledge often spread across individual system components. This hampers the consolidation of information relevant to clearly understanding business flows. Effective SOAs tend to be well-defined process-centric architectures that allow for better process design and knowledge [13], [55], and the monitoring of these processes from a business perspective rather than systems perspective [72]. This facilitates the next benefit.

Continuous process improvement: As a result of the clear representation of processes for translation into services, the monitoring and improvement of business flows is greatly enhanced. This allows for easier design, automation, monitoring, and modification of business processes [13], [30]. This also allows for the identification of business services that are the core competence of the organization, and the non-core services can then be candidates for substitution by those provided by vendors with the relevant expertise [28].

3.1.3 Cost efficiencies

Leveraging legacy systems: Moving to a service based approach allows existing and proven legacy system functions to be encapsulated as services on a new standards based integration platform. The services can encapsulate single functions or be composed of several smaller services representing legacy functions on a diverse set of hardware and software platforms [13], [18], [20].

Commoditization of Underlying Infrastructure: As the service paradigm permeates organizations, the services themselves can be virtualized from the underlying hardware platform. The underlying technology platform can be potentially substituted with ease, allowing for the best choice of platform for various services. The business can then focus on the core services while the infrastructure used to run the services become more of a commodity, to be leased or purchased from the provider of choice [13], [28], [72].

Rapid product development: As time progresses, the developed services become a core asset of the organization – a library of tested, ready to use, compatible components [13]. This could potentially reduce the time to pull together well-design tested functionality to meet new market needs [30].

Reduced development costs: In addition to the obvious reduction in development and testing costs brought about by modularity and potential re-usability of these modules [31], the learning curve of the development or assembly team could potentially reduce over time due to familiarity with existing services [13], [30], [31], [55], [91].

3.1.4 Risk mitigation

Phased Adoption: One of the advantages of SOA's modular approach is that companies do not need to take on a high-risk all-or-nothing approach to its implementation [28]. They can focus initially on opportunities that deliver immediate efficiency gains and incorporate new capabilities in a phased manner. These gains could be realized in terms of re-use of a created service internally [37], [55], provision or sale of the service to partners and customers, or development and maintenance cost savings by purchasing the services from reliable providers [28].

Reuse of Existing Assets: The reuse of existing components, in addition to providing cost efficiencies, also reduces risk in more ways than one [13], [20]. The enhanced business process incurs no new potential points of failure, and the maintenance of the supporting infrastructure continues to remain unaltered.

3.2 Organizational Strategy

The critical role of organizational strategy in gaining competitive advantage is reflected by investments in technology initiatives that are strategically important to firms' core business [39]. Little is known, however, of how SOA aligns with the strategy of the organizations adopting SOA. There is some academic literature relating to the potential strategic value of Web Services and SOA [30], [34], [44], [46] and other empirical studies are emerging [4], [51], [75]. Three of these studies stand out as potential stage-setters for future research and are discussed in the following paragraphs. These studies use varying approaches to examine the impact of service-oriented computing on agility and, hence, competitive advantage. Even as these studies break new ground in the area of the strategic value and competitive advantage using Web services implementations, the links between SOA and competitive advantage remain largely unexplored given the relative infancy of the adoption curve of the SOA.

The first of these studies, an analytical study by Huang and Hu [30], investigates the link between Web services and competitive strategy using a popular strategic management tool, the Balanced Score Card [36]. The authors use the scorecard's four dimensions to establish propositions about how Web services could support or improve the following perspectives - learning and innovation, internal business process, customer, and financial. The cases to

support the validity of these propositions are drawn from existing literature [44] [28], [29], industry reports [1], [10], [63], and vendor analyses from IBM and Microsoft.

The second study, by researchers at Infosys, examines the impact of Web services on business process flexibility and, hence, organizational adaptation [51]. The authors describe organizational adaptation as the ability of organizations to “change or adapt to their environment by altering routines or practices”, and link this to business process flexibility. Rooting their analysis on empirical data from experience with Web services implementations, they define a set of propositions that first draw a link between business process flexibility and organizational adaptation, and then draw a link between Web services and business process flexibility. Concluding with a review of the study’s contributions to knowledge relating to the role of technology in firm adaptation, the authors highlight the implications on “the role of IT capabilities in developing sustainable competitive advantage in organizations”.

The last of the studies by the authors of this paper links SOA to the concept of dynamic capabilities, a concept in strategic management that research scholars indicate may help firms gain competitive advantage in rapidly changing market environments [46]. The concept of dynamic capabilities is a widely accepted approach to understanding the competitiveness of organizations. The authors explain the attributes of SOA that may make it amenable to creating dynamic capabilities and attempt to lay the groundwork to research the channels through which SOA might be able to influence a firm’s dynamic capabilities.

The studies discussed in the preceding paragraphs have articulated analytical frameworks and strategies for investigating the business value of Web Services, but there is still a vast amount of research to be done in examining the strategic context of SOAs in practice.

3.3 Organizational Culture

The reality of defining distributed business processes to facilitate a direct mapping to technical services requires a new organizational culture according to one study [27], with business units taking on the role of modeling business flows as services, potentially redefining organizational boundaries between business and technology departments. The adoption of SOA as an enterprise solution, it appears then, poses a whole new level of challenges from an organizational structure and culture perspective because of this tighter integration across business and technology units [66]. Since the adoption of SOA is still in its early stages, there is little empirical data on the organizational issues relating to the adoption of SOA thus providing fertile ground for research.

The experiences of Standard Life (SL), a UK-based global financial services firm implementing an SOA-based strategy for the delivery of their services, throws some light on what kind of cultural changes are potentially required in an organization for the successful deployment of an SOA-based infrastructure [27]. The study determined, at a high level, that the benefits of SOA can be maximized when the IT and business departments work together seamlessly from the earliest stages of development to create components that can be reused across the organization. If business units can use tools based on maturing standards such as Business Process Execution Language for Web Services (BPEL4WS or BPEL), it is conceivable that the business processes can be modeled using these tools, and the generation of the underlying implementation could be viewed as merely a directly translation into a combination of existing Web services. The challenge of implementing such a working relationship needs to acknowledge and address the inherent turf wars and jockeying for position between the IT department and the lines of business (LOBs) in any organization.

The author of the study argues that most LOBs, however, are not yet prepared to take on this all-encompassing role of complete process definition using modeling tools. Hence, despite the perceived reduction of IT’s influence in such an organization, he suggests that there will continue to be a need for multi-skilled IT people beyond domain experts who understand the business. This need will extend to IT experts for the best service implementations, and IT-based management skills to understand the dependencies across services for reuse, and to negotiate with the various service users (intra- or inter-organization) when such dependencies are identified.

Management support, education/training, and the size of the organization could arguably also influence the situation, among many other issues [16], [21], [23], [54]. There is, however, a paucity of research literature beyond the study detailed in the preceding paragraphs, focused on how corporations are tackling issues related to organizational context or culture that the migration to a service-based environment may potentially cause.

3.4 Organizational Structure

Bieberstein et al [8] argue that a service based approach needs to be applied to an organization’s structure to meet 21st century business challenges. Existing organizational structures, they argue, have their merits but do not allow global enterprises to effectively align their business to potentially realizable IT benefits. They state that permeating a service team approach across all layers of the organization will meet business agility needs and minimize management overhead.

Function-based organizations may work for environments that have predictable requirements, but their inherent centralized control impedes the agility needed to respond to rapidly changing business demands. Geography-based organizations are ideal to address the unique demands of individual sites, and activities can be tailored to address contextual government regulations. It is extremely difficult to pursue a consistent strategy across the enterprise in such organizations, and the overheads are usually higher because of duplication of efforts across locations. Divisional structures are unwieldy and matrix organizations are extremely complex to administer.

Using the SOA metaphor in the context of organization structure, teams are organized around core tasks – i.e., services. Various service-based teams can be aggregated to implement higher level services, covering the gamut of departmental business objectives. The roll-up of services mirror the aggregation of objectives and goals, moving up from the departmental level (focused on objectives) to the business unit level with services focused on tactical execution, to the division level executing strategy, and finally to the group level focused on the corporations mission and goals. This organizational structure, it is argued, enables the organization to take on new opportunities and effectively address competitive threats.

From a practical perspective, available literature does not, however, provide great insight into the organizational transformations that corporations are actually executing, if any.

3.5 Potential Implementation Challenges

Although industry vendors have rallied around the concept of service-oriented computing [64], standards are poor in key areas such as security and transactional integrity [31], [44], and there still is no single unified view of the basic communications standards involved across the board [43], [47].

Standards notwithstanding, by virtue of crossing administrative domains with potential loss of visibility and control, the new cross-organizational business models put an increased emphasis on non-functional business requirements [52], [58], [74], [78] such as performance, reliability, transactional integrity, and security along with strategic requirements like compliance to contextual regulations imposed by industry regulatory bodies [47]. Additionally, with the increasing number of interfaces in a typical inter- and intra-enterprise service-oriented implementation, addressing these systemic issues in an environment of multiple administrative domains, straightforward in theory, becomes a complex problem in practice spanning technical and business arenas [47], [69].

Despite the many potential benefits of information technology innovations, organizations have generally found it very difficult to achieve the promised benefits [43], and the successful implementation of SOA across the organization appears to have its fair share of challenges. It is interesting to note that even in the limited scholarly work on the use of SOA in the business domain, an empirical study of two European banks indicated that the “[business] service concept was difficult to define in practice” [4]. The study collates and contrasts the potential value of SOA and the actual results of the SOA implementations. While some benefits were realized in terms of integration, the authors conclude that SOA is difficult to implement in practice because business processes are not included in the service definitions, which tend to be technical service implementations of the business process flow. Even experienced systems developers are unfamiliar with the core differentiating principles of service-oriented computing and the operational management of applications developed as services. The study concludes that SOA offers some advantages but the technology implementers have a long way to go before their efforts can result in the benefits outlined by current reports.

An early study by Iyer et al [34] argues the advantages of Web Services, a popular technology implementation of SOA, as an enabler of dynamic business networks using a popular stakeholder model for IS architecture [90]. The authors extend Zachman’s architecture model to build a stakeholder model for Web Services along the dimensions of the owner, architect, builder, and end-user, and argue the benefits of Web Services along these dimensions to be ease of sourcing the IS implementation, modularity, IS integration, and ease of access respectively. This framework offers a possible vehicle to study the challenges and real-world benefits of SOA implementations across the business and technology domains, but there is much work to be done in this area to provide better insight into the applicability of service-oriented concepts to real-world business processes.

Given the nascent, but fast growing, adoption curve for SOA, the study of real-world implementation issues appears to be fertile ground for future research.

3.6 Governance

Existing research indicates a high correlation between company profits and good governance of information technology [87]. IT governance is defined as “the decision rights and accountability framework for encouraging desirable behaviours in the use of IT” [88], and is tied inexorably to organization-wide corporate governance processes. In the light of various corporate accounting scandals in the last few years, corporate governance and compliance to industry specific and general accounting regulations has become a key goal for organizations. In addition to enabling core business of organizations, IT is a key enabler to realizing compliance across the organization. Hence, the governance of IT in itself becomes extremely critical. Although every enterprise engages in

monitoring IT investments and use, the rigor, formality, and processes for governance may differ considerably [50], [88]. The cross-domain nature of services, with the services potentially being used across not only internal business units but by entities external to the organization, makes IT governance in general, and SOA governance specifically, a complex process [50].

Here again, there is very little literature available in this area beyond the studies referenced earlier in this chapter. Fricko [27] specifically suggests the creation of a governing body to oversee the development process and ensure compliance with SOA principles. Mitra [50] echoes this suggestion while detailing a suggested organizational structure for governance. A third study [8] suggests the need for a collaboration and coordination fabric, but define it to be “a conceptual artifact that is used to connect interrelated entities by providing communication, coordination, and collaboration mechanisms”.

It appears, then, logical to infer from the available literature that the creation of an organizational entity for coordination – a program or project office – would help in the initial adoption and ongoing governance of an SOA implementation. However, there appears to be little documented evidence beyond the literature referenced in the preceding paragraphs to validate or dispute this logical inference.

Table 1: Summary of factors influencing the organizational adoption of SOA

| Organizational Factors | Summary of Research |
|-------------------------------------|---|
| Perceived Value to the Organization | The bulk of literature on potential value of SOA is vendor sponsored. There is some academic literature relating to the potential strategic value of Web Services and SOA, and a few empirical studies of realized business value are emerging. |
| Organizational Strategy | There is little research on how SOA aligns with organizational strategy, beyond a handful of studies suggesting frameworks for alignment with strategy. |
| Organizational Structure | There is a dearth of academic literature, the existing studies indicating the potential for increased business responsibility for process modeling. |
| Organizational Culture | There is a dearth of academic literature, with the existing analytical research indicating the blurring of lines between IT and business departments that could potentially cause turf wars. |
| Potential Implementation Challenges | There is minimal academic literature available. Existing literature indicates that standards and the availability of tools are issues, as is the ability to handle non-functional requirements like performance and security. |
| Governance | Available analytical literature indicates the need for an intra-organizational entity that governs the adoption and ongoing use of SOA, but there is no empirical evidence of how SOA is being managed. |

4 Towards a Research Agenda

Seminal works in the area of service-oriented computing [8], [38], [59] lay out research road maps identifying the technical and business challenges in implementing SOA at an enterprise level. There is, however, very little by way of critical research into the organizational challenges of SOA. Even though the industry has widely accepted the potential of SOA as an enterprise strategy, there is no road map for the wider organizational factors influencing the adoption of SOA, and little critical research addressing the pragmatic business impacts of adopting SOA.

Studies of the practical business impacts of SOA are crucial as the number of SOA implementations grows, and are required for a better critical understanding of this popular architectural concept that is being rapidly adopted by industry organizations. These studies could well provide frameworks, guidelines, and best practices for the effective adoption of SOA as an enterprise strategy.

4.1 Proposed Research Framework

Reviewing existing technology adoption and diffusion literature, it appears that the associated research strategies distinguish the adoption of new technology from the diffusion of the technology. Consequently, we propose a preliminary research framework that distinguishes between the adoption and the subsequent implementation of an SOA-based infrastructure.

The decision to adopt SOA may be understood to be (i) driven by the perceived business value of SOA to the organization, (ii) driven by the organizational strategy, (iii) influenced by organizational constraints and challenges, and (iv) guided by any governance issues to be considered. The subsequent implementation of SOA across the

enterprise may impact and be influenced by (i) the governance policies and procedures of the organization and (ii) any organizational constraints. The implementation also will arguably need to deliver some business value, and may provide a set of best practices from the lessons learned during the enterprise rollout of SOA.

The conceptual model depicted in Figure 2 captures the relationship between the factors influencing the adoption of SOA, and the potential impact areas of SOA adoption, providing a research framework to examine the adoption and diffusion of SOA across the enterprise.

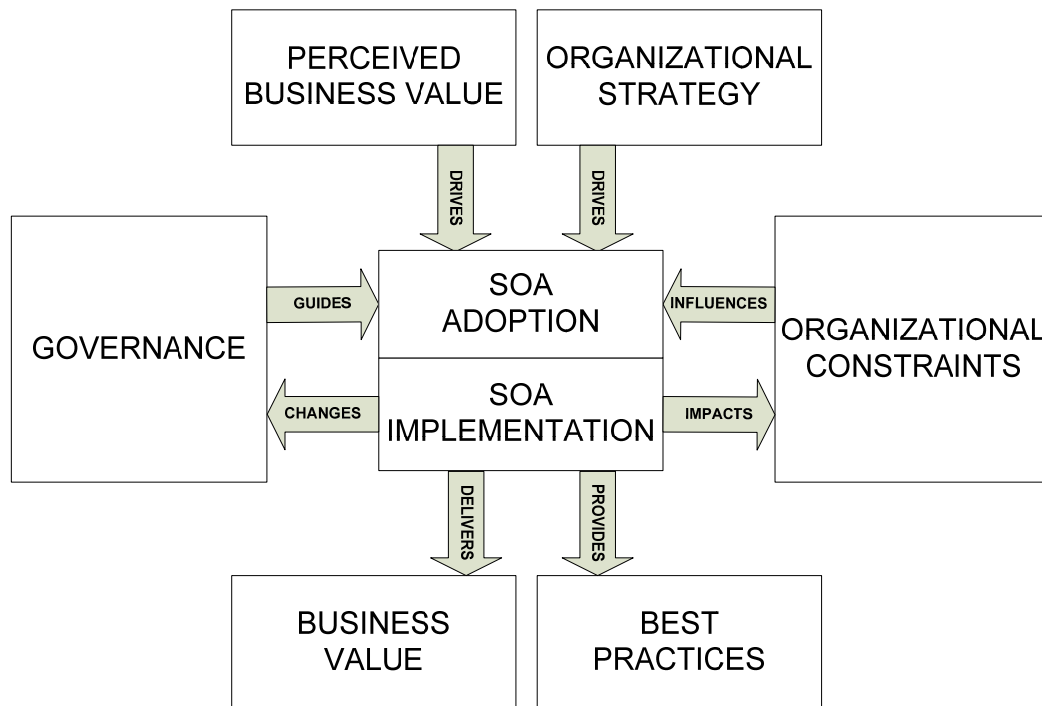


Figure 2 - Conceptual Model of the Research Agenda for the Organizational Adoption of SOA

4.2 Suggested Research Questions

Building on the proposed research framework in the preceding section, the possible research opportunities in studying the adoption of SOA are categorized along (i) the factors that influence the *decision* to adopt SOA, and (ii) the factors that impact the *actual adoption or implementation* of SOA across the enterprise.

4.2.1 Investigating the factors that influence the decision to adopt SOA

As discussed in the preceding section, technologies are adopted by organizations based on what their value is perceived to be [41]. An interesting question would be to examine how the value proposition of SOA meets the needs of organizations, and whether the value proposition varies with industry sector, organizational size, and stage of growth. The inter-play of the perceived value vis-à-vis the organizational strategy may also provide an insight into what drives the decision to adopt SOA as an enterprise strategy.

From an organizational strategy perspective, current research argues that the design of service oriented business flows is moving up the corporate ladder [4], [47] to the strategic and management level. This sets the stage for modular services-based business design to be driven from the top while being implemented from the bottom up. Despite the number of studies examining the influence of IT-related capabilities on a firm's performance, there is still ongoing work to be done to clarify how and why these technologies and capabilities may shape a firm's performance and competitiveness [7], [68]. There is a lot of work to be done in understanding how organizational strategy aligns with and drives the choice of SOA as an enterprise strategy. Existing frameworks linking SOA to performance and competitiveness [30], [45] could be applied to real world situations and tested. Some interesting questions to explore in this area include - what organizational strategies does SOA provide a good fit for, can the value proposition of SOA be aligned with the value proposition being pursued by the organization, and even how does an SOA-based infrastructure help companies with different competitive strategies?

The impact of organizational structure, culture and other organizational factors, such as possibly size and industry sector, on the decision to adopt SOA also provides significant opportunities for research. In addition, studying the impact of environmental factors such as standards, availability and maturity of tools, and successful case studies that may affect the decision to adopt SOA, could provide interesting insights into the adoption of SOA.

Similarly, potential governance requirements that may result from the decision to use inter-organizational services could have some bearing on the adoption of SOA.

4.2.2 Investigating the factors that impact the implementation of SOA

Beyond the factors that impact the decision to adopt SOA as an enterprise strategy, the examination of the actual organizational adoption of SOA and its impact also provide fertile ground for future research.

The evolution to the service paradigm is equally a business and IT transformation [73], and the key to effectively deploying SOA across the enterprise, is to recognize that it is an architecture that transcends technologies and could actually be independent of the underlying technologies that implement it [13]. Not many business people, however, are familiar with the term 'SOA', and many firms whose SOA implementations have fallen well short of expectations possibly did not include the business aspects of the move to a service-based deployment [66]. Thus, one of the biggest challenges in SOA adoption is understanding which business functions can actually be viewed as business services, and how this set of granular services can be used to create a service framework [24]. The understanding of how SOA is actually implemented on the ground, the associated implementation issues, the true business value realized, and best practices learned are all areas in which the academic literature could be enhanced.

The impact of SOA on organizational structure and culture will also need to be addressed along with any other organizational constraints, if SOA is to be successful across the enterprise. Along the same lines, the governance structures that are needed to guide the adoption and ongoing use of SOA are of equal interest as is the impact of SOA on existing governance requirements and organizational policies.

4.3 Potential Research Approaches

The following is a discussion of the various research options that may be suitable to the organizational examination of SOA. It is important to note that while this discussion examines the applicability of the possible different approaches to research design, methodology, and data collection in the following sections, it is not intended to be an exhaustive discourse on the full set of possibilities, but more of an initial agenda or road-map. Future researchers may use various combinations of these methodologies, drawn from existing research literature [49], [56], depending on the research context.

4.3.1 Research Design

The lack of scholarly material on the practical use of service-oriented computing may be attributed to the relatively early stages of adoption, and thus indicates the initial suitability of an exploratory or descriptive approach to address this deficiency in academic investigation [56]. As further data are collected, explanatory studies to identify the nuances of specific contexts could emerge. From an epistemological perspective, the study of the adoption of SOA could be equally a positivist approach – along the lines of available technology diffusion models - or interpretive, the choice being driven by the question of interest.

4.3.2 Research Context

It is interesting to note that the universal applicability of IT lends itself to studies of SOA adoption in the context of various industry verticals. It is certainly possible that there may be unique features of certain industries that may strongly influence the adoption of SOA as an enterprise strategy. It follows then that the study of SOA adoption may provide interesting results when conducted within industry verticals, and by extension across industry verticals. These studies could be cross-sectional taking a snapshot in time of the context, or longitudinal - a time-lag study of the impact of introducing SOA into the enterprise.

4.3.3 Research Methodology

A case study approach could work equally well for each of the facets of SOA implementation discussed in the preceding section, and this proposition is given credence in the study by Benbasat et al in their treatise on the use of case research strategy in information systems research [6]. Benbasat et al argue that case study research may be used successfully in explorative studies, and the resulting generation of hypotheses is a legitimate vehicle to add to the body of IS knowledge. They believe that case studies are "well-suited to capturing the knowledge of practitioners and developing theories from it". They introduce the applicability of this research method to the IS field by citing how early studies of end-user computing resulted in management theories by descriptive studies of organizations, and arguing that the IS field is increasingly concerned with managerial and organizational questions, and hence the context of the usage. In their evaluation, Benbasat et al conclude that case studies can help analyze technology implementations and provide hypotheses about the impact of technology on organizations. Case studies may be used effectively for either longitudinal (within an organization) or cross-sectional (across organizations or industry vertical) research. Although, generalizability has been identified as a critical flaw in case study research, it may be argued that even single case studies of early adopters of SOA may provide valuable guidelines and best practices for future adopters.

Although survey-based studies could arguably be used to examine the context of a single organization, they lend themselves to cross-sectional studies. Existing technology adoption and diffusion models could be used or extended by survey-based studies used to propose and/or test models for the adoption of SOA. Specifically, cross-organizational surveys could potentially be used to understand the alignment of SOA strategy and organizational strategy. These could be quantitative surveys, for example, gathering data on the dimensions of specific corporate strategy implementation tools (Balanced Score Card, etc.) and correlating them to the SOA adoption. They could also be qualitative to get a better understanding of the impact of the individual organizational context.

It may seem, at first glance, that the use of experiments does not fit with the understanding of SOA adoption, but it may actually help in understanding SOA in situations where SOA is being adopted iteratively and not as a big-bang approach across the organization. It also may be used, for instance, in organizations taking an iterative approach to SOA adoption by focusing on specific SOA projects to study the alignment of SOA strategy with the larger organizational strategy. The use of experimental research to examine organizational structure does not appear to make logical sense, given that organizational structure is a macro issue and cannot be a controlled experiment. It does seem logical, however, to use experimental research to study the potential culture clash between business and systems teams when working on a controlled SOA project. Where it seems most appropriate, though, is the governance of SOA. The establishing of a governance structure (be it process or organizational) to oversee the rollout of a controlled or small-scale SOA project may be a suitable way to understand the challenges of SOA governance as it is rolled out across the organization. More generally, experimental research may be applicable for longitudinal studies where the goal is the understanding of a specific attribute of SOA adoption within a controlled environment or a phased SOA rollout.

Content analysis, in the authors' opinion, holds little additional value as a methodology for research in the current SOA context. There is a significant amount of academic information available on the potential use of SOA and even more information from vendors and consultants. Analyzing this could augment other studies by providing a level of validation of the results [35], but as a stand-alone method may not be relevant given the biased nature of existing SOA-related content. As the situation changes and more data inform the academic arena, it is possible content analysis may prove to be of significant value. The same may be said of existing statistics research. The methodology may not be very effective in itself given the scarcity of existing data but may add value as supporting data for other methods.

4.3.4 Data Collection

Yin [89] argues that the attributes of qualitative and quantitative are not types of research, but instead are attributes of types of data, and hence, case study research may be qualitative or quantitative in nature, and surveys may be used not just as quantitative measures but as qualitative data collection tools. Indeed, just as research methods may be combined contextually to allow a more holistic study, qualitative and quantitative data may be used to complement each other depending on the research context [35], [49].

The advantage of qualitative studies, however, is that they are particularly suited to an exploratory or inductive approach in researching new relationships between phenomena and in understanding the process by which events and actions take place [48]. The flexibility that a qualitative approach facilitates is significant in such attempts at new discovery, allowing the researcher to modify the focus and design of the study given the emergent nature of the topic. In his book on the design of qualitative research, Maxwell references prior scholarly work in this area [60], [71] to emphasize the practical outcomes of using a qualitative approach. He specifically mentions the generation of "experientially credible" results and theories and the conducting of evaluations that are intended to improve "existing practice", both of which should be key goals of the study of SOA in practice.

Quantitative studies, on the other hand, may bring a different understanding of the study of SOA adoption. By virtue of being a data condensing technique [65], they allow researchers to study the big picture view across various data collection points. Hence, they may be well suited for studies that are looking to establish a pattern of behaviour relating to SOA adoption. Since it allows for the measuring of concepts and establishing causality across variables [9], quantitative data analysis could also be a valuable tool, say, for measuring alignment with strategy, attributes of organizational culture, and even implementation challenges.

5 Conclusion

The service concept is a new way of developing systems that has evolved from good engineering practices but requires fundamental changes in the way organizations view business processes [4]. It follows that the adoption of service oriented computing cannot be without impact on the organization – and it appears that the impact could possibly be felt across the organization's internal boundaries and beyond them to the interfaces with partner organizations. In IS research, the study of such innovations that could potentially alter business operations and competitive strategies is important in understanding the contribution of the innovation to the organization [76].

In sifting through the available analyses of SOA reviewed in the preceding sections, it appears that the successful adoption of service-oriented computing as a technology strategy could have not just potentially significant technical challenges but significant impacts on the organization as a whole. There are some studies emerging that address the

challenges of adopting SOA [14], [15], [38]. However, the majority of research in the information systems and technology fields appears to focus on the technical challenges of implementing an enterprise SOA solution. The lack of a research agenda to understand the factors that influence the adoption and implementation of SOA provides the motivation for this paper.

The suggested research questions and options for research strategies discussed in the preceding paragraphs are based on existing technology adoption and diffusion literature, ensuring that the proposed research framework is grounded in generally accepted concepts. While these research questions, suggested strategies, and the associated framework are by no means intended to be a complete and exhaustive detailing of options, they provide a starting point for the study of the organizational factors influencing and impacted by SOA adoption. In setting this research agenda and proposing a preliminary research framework for SOA adoption and implementation, this paper attempts to lay the groundwork for future studies.

Given the scarcity of existing models for research into the organizational impacts of adoption SOA, this conceptual framework and associated research agenda provide a very useful starting point for the study of the service-based approach as an enterprise strategy. Further research and empirical studies will arguably provide valuable feedback to validate and refine the proposed research framework.

Whether future studies of the organizational adoption of SOA are empirical or analytical, positivist or interpretivist, single- or multi-methodology based, each of these studies could and probably will provide valuable insights into practical implementations of SOA. The outcomes could be best practices, pitfalls to be avoided, and/or general guidelines for the successful implementation of SOA across the organization. Success of implementation is a rather subjective phrase, and the results of each study will therefore need to be viewed in the context of the organizational objectives of the adoption of SOA. It is conceivable that interviewees or respondents within organizations may choose to present a more optimistic picture of their experience, but over time successive studies could mitigate the distortion caused by potential outliers, and they will surely add a great deal to our understanding both in terms of practitioners and future researchers.

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