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SERVICE-ORIENTED ARCHITECTURE ADOPTION: KEY FACTORS AND APPROACHES

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ABSTRACT

Organizations across many industries have moved or in the process of moving towards a service-oriented IT architecture. This article explores the challenges and impacts that organizations are facing in the process of adopting a service-oriented architecture with Web services. While some adoption issues are relevant for any organization, others depend on the industry and type of organization. The results of multiple case studies suggest that differences in the business environment need to be considered in the decision of when and how to move to a service-oriented architecture with Web services.

Keywords: Service-Oriented Architecture, Web Services, Case Study, Information Technology Adoption

INTRODUCTION

Many organizations have adopted a service-oriented architecture (SOA), but there are still many more that have been unwilling to do so [24]. This reluctance to adopt by organizations contrasts with earlier forecasts by some of the proponents of SOA that anticipated it to have been widely adopted by now. The objective of this research was to examine the challenges that organizations faced when pursuing an SOA adoption. The contribution provided by the research presented in this paper is two-fold. First, we reveal and explain the significance of several key factors that pose a challenge for realizing an SOA with Web services. Second, we develop a model that is based on the challenge factors that can guide organizations in determining their approach and timing of moving towards an SOA.

The experiences of eight firms across multiple industries are used to identify these key factors and develop a model that describes how these factors influence the decision to move forward with an SOA initiative. The factors are organized using the technology-organization-environment (TOE) framework [6].

We next present a literature review for this research. The methodology employed during this research is then detailed and is followed by a description of the participating organizations and an overview of key issues that emerged. A discussion of the findings examines the key challenges encountered in the cases. From this analysis we then identify four key areas that an IT manager should consider in determining when and how to move to SOA. The paper concludes with a discussion of its limitations and proposed future work.

LITERATURE REVIEW

Innovation Adoption Research

The adoption of new information technology (IT) has been widely researched in the past and several models have been established to explain adoption decisions and processes. Studies of innovation adoption have primarily focused on two different contexts: individual level and organizational level [10]. The latter is relevant in the context of infrastructure technologies, including Web services. In the context of EDI, Kwon and Zmud [15] and [22] utilize five broad categories of variables that influence the adoption of an innovation: innovation, environmental, organizational, task, and individual characteristics. These studies focused on the organizational level adoption of EDI and found only three categories to be relevant: innovation, environmental, and organizational. DePietro et al. [6] also used those same three categories as the elements of a firm's context that influence the process by which it adopts and implements technological innovations. This technology-organization-environment (TOE) framework has also been applied in other research on IT adoption [14][32]. The results of some studies suggested that environmental factors are the predominant forces that motivate firms to adopt [22], while others found that organizational factors emerged as the most salient for the adoption of interorganizational IT [5]. We will use the TOE framework to organize our findings and to discuss the challenges of adopting an SOA based on Web services.

Service-Oriented Architecture

A service-oriented IT architecture is an architectural style for building software applications that use available services in a network [21]. It is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains [18][29]. An SOA may support a variety of different communication protocols, but common protocols based on open standards (e.g., SOAP and WSDL) are used in current SOA implementations [8][21]. These open standards are by no means the only technology with which an SOA can be established, and it is likely that most large SOAs will also provide access to services with a mix of technologies that are not necessarily based on the WS-*[1] standards. Nonetheless, Web services based on WS-* standards are at the core of the integration products of the major vendors, including IBM, SAP, and Oracle, and according to recent industry surveys, they remain the prevalent underlying technology standard for the major SOA platforms [24]. Perhaps the key aspect that differentiates SOA with Web services from prior attempts of distributed computing (e.g., using CORBA) is the level of standardization and ubiquitous acceptance of these standards by the major vendors and service providers. Thus, we focused our attention in this paper on SOAs realized with Web services.

For the purpose of this research, we adopted the definition for Web services put forth by the World Wide Web Consortium (W3C), which states that Web services are software systems designed to support interoperable machine-to-machine interaction over a network with an interface described in a machine-processable format, specifically the Web Services Description Language (WSDL) [12]. Other systems interact with Web services in a manner prescribed by its description using SOAP messages, typically conveyed using Hypertext Transfer Protocol (HTTP) with an Extensible Markup Language (XML) serialization in conjunction with other Web-related standards. A service registry based on the Universal Description Discovery & Integration (UDDI) standard can be employed to publish and discover Web services. Web services enable the SOA concept to be applied in a Web-based environment.

According to the Gartner 2008 hype cycle for emerging technologies [9] basic Web services are seen to be fairly mature and reaching the "plateau of productivity," while SOA is placed on the "slope of enlightenment" as costs and benefits are now being viewed more realistically. Best practices for SOA, however, have still yet to mature [11]. SOA adoption overall is increasing, albeit slower that initially anticipated [24]. Consequently, the question of how to arrive at an SOA that enables the expected business benefits at an acceptable cost merits further examination and best practices need to be developed.

[1] WS-* refers to a set of standards that include SOAP, WSDL, UDDI, and other Web services related standards typically prefixed with WS-, such as WS-Security or WS-BPEL

Industry Factors

Presumably, the environment in which a firm operates is likely to vary between industries. Some of these differences may be pertinent to the adoption of an SOA with Web services. In the context of EDI, for instance, the power relationships between firms in a specific industry have played an important role in the adoption of EDI. Therefore, the power that a relatively large and influential firm has over another firm, which has been examined in past EDI research (see [13], [27], and [30]), is likely to also lead to some variation in the adoption of SOA in different industries. In the past, firm size has also been identified as a factor influencing the adoption of new technologies. Large firms are more likely to adopt new technology than small firms. Another difference relevant to the adoption of Web services is the maturity of vertical standards for business-to-business exchanges [4][20]. These vertical standards (e.g., POSC in petroleum industry, HL7 in health care, and LegalXML in judiciary system) are critical, as they provide industry specific standardization of the business documents that are exchanged in the payload of Web service messages. Consequently, we expect that the industry context in which an SOA with Web services are adopted is important and that the adoption timing and approach are likely to vary between industries.

Challenge Factors

This study attempts to identify the key factors that are challenges for the adoption of an SOA using Web services by examining eight cases in four different industries. We apply the TOE framework [6] simply to organize and discuss the factors that emerge from the case evidence. The framework provides three categories: technology (innovation), organizational, and environmental. Since the focus of this study is to elicit and examine factors across industries, we extended the framework by further distinguishing factors in the environment category into horizontal and vertical factors (see Figure 1).

With respect to their relevance and assessment, factors in the horizontal environment category are expected to have similar implications across industries, while vertical factors are expected to differ between industries. Consequently, these factors can help explain and perhaps predict the variation in the adoption of SOA based on Web services in different industries. An awareness and further examination of these factors are important for IT decision makers trying to determine how to approach and time the adoption of an SOA, given their particular business context.

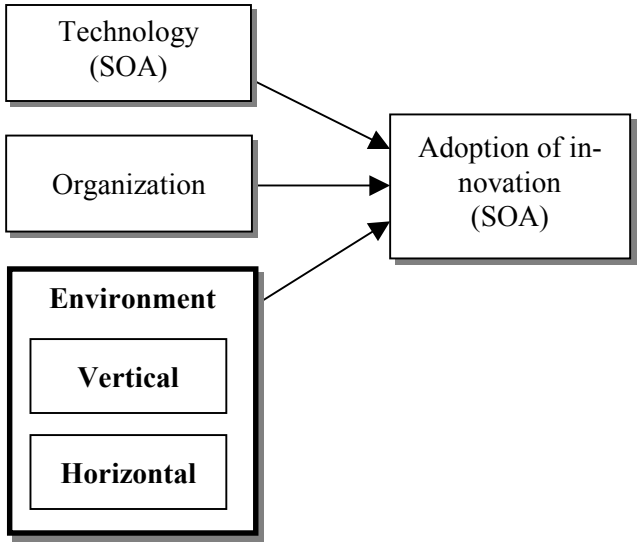

Figure 1: Categories of Factors

METHODOLOGY

This study employs a multiple case research strategy to explore how organizations are approaching the adoption of a service-oriented architecture. This strategy was chosen because the adoption of an SOA is a contemporary event that can be observed in a real-life context and for which substantial scientific theory has not yet been established. This research addresses the factors that influence the adoption of an SOA as well as how and why these factors play a role. The qualitative data from the cases were collected and analyzed following a rigorous process based on the procedures outlined by Strauss and Corbin [26] and ideas presented in [7] and [31].

Research Design

In this study, it was important to gain an understanding of how organizations approach the adoption of an SOA. A goal was to elicit a variety of approaches and challenges. Therefore, we decided to use a multiple case design rather than focus on a single case. Multiple case designs allow for cross-case analyses, which force the investigator to look beyond initial impressions and see evidence through multiple perspectives [7].

The research process, including data collection and data analysis, followed a research protocol that described the overall research goals, data collection sources and procedures (i.e., interview instrument), and the data

analysis process. All research documents, including the research protocol and documents produced during data collection and analysis were stored in a secure online repository shared among the researchers. The qualitative analysis tool NVivo 2.0 [23] was used to manage and support the analysis of our research documents.

Case and Participant Selection

All of the organizations chosen to participate in our study are major national organizations in their respective industries in the United States and had either employed a project utilizing Web services or were considering developing an SOA based on Web services. While the availability of organizations adopting SOA during the time of data collection limited the selection of participating organizations, we obtained eight cases with varying levels of SOA adoption and industry characteristics that provided us contrasting results. For each case, a minimum of two participants were selected based on the recommendations of our contact person. At least one individual had technical expertise with respect to designing and implementing SOA (e.g., IS analyst) and at least one had managerial responsibility for the SOA projects and a broader business perspective (e.g., a vice-president of information systems). In total, we interviewed 17 individuals in eight participating organizations during the spring of 2004 and spring of 2005.

Data Collection

The interviews lasted on average 45 minutes and all but three interviews were conducted face-to-face. The three interviews with organization F3 were conducted by phone. The interview process was guided by a semi-structured interview guide. This guide contained eight open-ended questions and was used by interviewers to ensure that all relevant areas of interest were consistently addressed in the interviews (see appendix). The questions elicited the firm's organizational and IT background, the perspective and involvement of the interviewee, current SOA initiatives, expected benefits, the key challenges, long-term solutions and temporary workarounds, as well as key lessons learned in dealing with an SOA.

Each interview was recorded and transcribed. The researchers then created summaries of the transcripts and provided the participants with an opportunity to make corrections, such as adding important details or removing sensitive information. In addition, a description for each case was produced, which is summarized in the case evidence. Each summary was interpreted by each of the three researchers independently. Several potential factors and categorizations (e.g., security concerns, immature standards, etc.) were identified prior to the analysis based on the literature review. While some theoretical constructs were known a-priori, the nature of their relationship with adoption was not known and the possibility for additional factors of influence was left open. The findings from the individual cases are consolidated and presented in the cross-case analysis below.

Data Analysis

The basis for the data analysis was the summaries produced for each of the interview transcripts, which were reviewed and validated by the participants. The analysis processes consisted of three major phases: 1) preparation of data sources, 2) open coding and category development, and 3) development of relationships and the resulting theoretical model.

Figure 2 depicts the sequence of events that were undertaken by the researchers to perform the data analysis process.

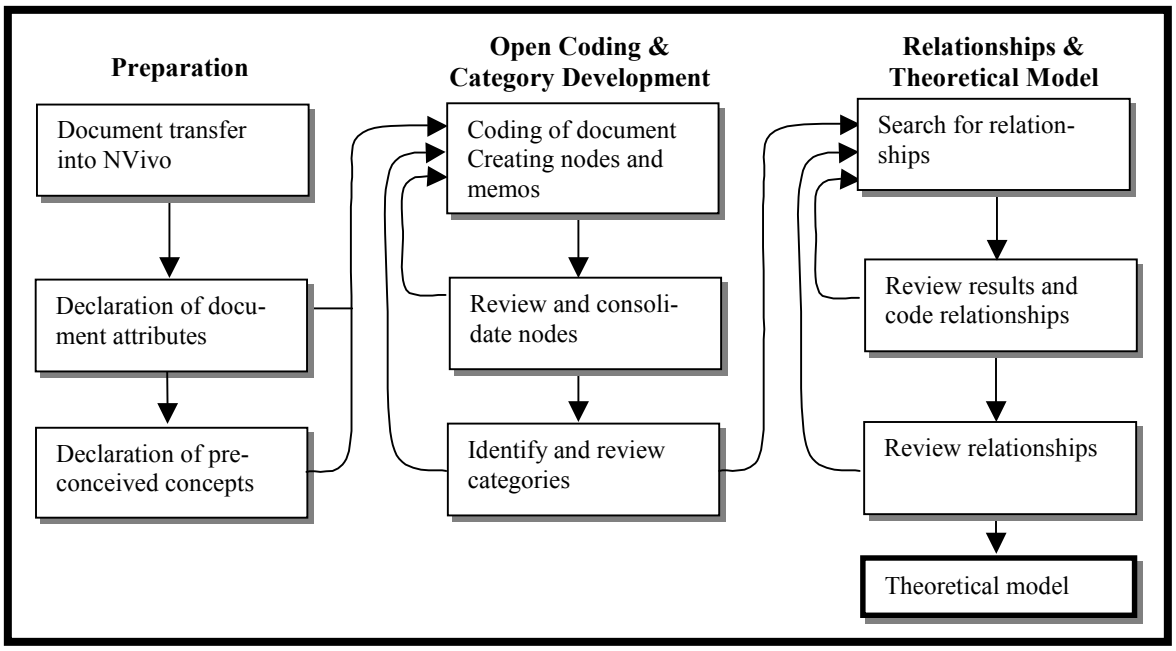

Figure 2: Data Analysis Process

Preparation of Data Sources

Open Coding and Category Development

Each document went through a thorough coding process. The task of coding the documents was divided equally among the three researchers. Text passages were examined and associated either with one or more of the existing concepts or new, unassociated *concepts* that were created in the process. This coding process produced a catalog of concepts, which were subsequently compared, consolidated, and organized into a tree hierarchy during face-to-face meetings with all three researchers. Upon completion of multiple iterations of the coding process, each of the documents had been coded or reviewed by multiple researchers. This process supported the independent development of concepts by each researcher and also provided some control over individual coding bias.

The coding activities at this stage best resemble the *open coding process* described in Strauss and Corbin [26]. Several key themes emerged in the process of open coding and subsequent consolidation. They were marked as categories that may lead to potential elements of emerging theory [26]. While frequency counts of text passages coded in a node helped to identify potential categories, each category candidate was carefully evaluated on the significance of the statements made in the interviews as well as their plausibility based on the existing literature.

Identification of Relationships and Theoretical Model Development

Once the iterative process of open coding and developing categories was completed, the focus was on identifying potential relationships among these categories. This activity can also be considered part of the *axial coding process*, which "looks at how categories crosscut and link" [26]. This procedure served to develop the theoretical framework that emerged in our analysis. Once all of the candidate text passages were evaluated and key relationships were identified, the documents were reviewed and coded once more, specifically looking for statements pertaining to these relationships. This activity helped to refine and solidify the theoretical model, which is part of the *selective coding process* outlined by Strauss and Corbin [26].

CASE EVIDENCE

The following Table 1 summarizes each organization interviewed and its specific views related to the decision factors considered for SOA adoption.

Table 1: Case Overview

Label	Description
F1	F1 is in the financial industry and has applications utilizing Web services that have been operational for over a year. This organization is primarily a provider as opposed to a consumer of services and its stated goal is to convert all of its existing applications, which range from mainframe to web applications, to fit an SOA based on Web services. These systems all pass XML messages, which use industry standards (IFX and OFX) when possible. Web services are currently not published in a public registry, and initially Web services were only available internally within the firewall or through a virtual private network (VPN). More recently, the WS-Security standard was leveraged to secure some Web services. Its primary motivation to move towards an SOA based on Web services was to provide a standard platform for development, provide a method for integration of the various systems, and support its desire to reuse code.
F2	This organization is also in the financial industry and has many applications in production that employ "pre-Web services" XML-based messaging, but it has a limited adoption of actual Web services. Prior to the introduction of Web services, the organization developed its own standard for formatting XML messages similar to SOAP within its own firewall and considered this home-grown architecture to be service-oriented, albeit not based on open standards.
F3	F3 is in the financial industry and operates as an application service provider and licenses the financial software it develops. While some industry standards exist (e.g., OFX and IFX), they do not provide all the data required in some of their existing applications. While the architectural structure could be converted to an SOA model, the IT management believes that the cost of conversion currently outweighs its benefits. The real drive for change will occur when the organization's key customers or partners start demanding functionality delivered through standard Web services.
F4	This organization is also in the financial industry and its primary role is to serve as the facilitator of business-to-business communications between consumers and financial services vendors. These vendors represent significant players in the financial industry and they exert great influence over the protocols by which communication takes place. The organization does not currently have an SOA or any applications that utilize Web services. While it sees a number of benefits related to Web services, it is only delivering what its business partners demand. If its business partners were to require Web services, it would meet those requirements.
M1	M1 is a manufacturing organization and is currently putting integration structure in place to facilitate moving to an SOA. One application is currently Web services-enabled, and plans exist to interface the HR package with existing systems and the portal project using Web services. XML over HTTP was previously used to feed information to the existing portal, but the portal vendor has discontinued this feature. The call center application package is Web services-enabled, which may provide an opportunity to employ Web services.

Label	Description
M2	This organization is another manufacturing organization. The organization is currently in the middle of a large project of implementing an ERP system worldwide. The organization has been involved in a small project using Web Services but has not embarked on a larger scale SOA effort. It sees Web services as providing an opportunity to reduce latency (providing real time data and inventories with all its partners), therefore allowing for cutting costs. It is concerned that SOA and Web services may currently offer more hype than real functionality and is waiting until it can demonstrate a good cost benefit for using the technology before applying Web services on a larger scale.
R1	R1 is a large retailer and has two major IT divisions: corporate IT and retail locations. Its corporate efforts include a lot of legacy COBOL applications running on mainframes, with all new work being developed on the J2EE platform. One Web service application has been developed to interface with a third party system. A second application interfaces to an interactive voice response (IVR) system. Its second effort is related to supporting the organization's many retail locations. The approximately 1,000 retail locations use a single IT model, which is based on the Microsoft Windows platform. A major Web service project in this area that will be used to communicate inventory demands between the retail locations and the corporate location is in the "proof-of-concept" stage.
H1	H1 is an intermediary in the health care industry. It connects customers with suppliers for long-term health care products. Historically, it has interacted with business partners using EDI, first through VANs and now primarily through HTTPS. It also has some experience transferring XML over HTTP. Essentially all IT is based on the Microsoft Windows platform and most applications are custom developed in-house. It currently is developing its first Web services with a supplier to transmit data in real time. It sees Web services as a solution to provide interoperability and move from a batch mode, which is typical of its EDI, to real-time interactions. The health care industry is a highly fragmented industry that is traditionally slow to adopt any new technology. As a technology leader in the long-term health care industry, this organization faces the challenge of convincing business partners of the value of moving to Web services that can be leveraged in an SOA.

CROSS CASE ANALYSIS

The data analysis of the cases led to a number of key themes that emerged from the evidence (see Table 2). The following analysis presents these key themes, or challenge factors, across all eight cases. We distinguish vertical factors that have the potential to explain variation of SOA adoption between industries and horizontal factors that play a role independent of industry. A key challenge for adoption of an SOA based on Web services is the lack of external demand for Web services, regardless of the industries represented in this study. The adoption of an SOA is influenced by factors that are industry specific, as well as factors that apply to any organization. The key vertical factors that emerged in the case evidence are industry leadership and vertical payload standards. Industries can also vary in their response to new technologies in general, whether it is fax or Web services. Our case evidence suggests that industry fragmentation can play a key role.

In addition, there are also a number of challenges that organizations across industries are facing, including expertise related to SOA, justification, management support, performance concerns, vendor support, and business partner demand. An overview of the factors and their manifestation for each case is provided in the Tables and Figures. A "+" indicates that statements made by the participants suggest that the factor is a challenge to the adoption of Web services. A "–" indicates that statements explicitly suggest that this factor is not a challenge. A blank indicates that factor was not addressed in the case, and an "o" indicates that the factor was addressed but the statements made by the participants are inconclusive.

Table 2: Case-Factor Overview

		F1	F2	F3	F4	M1	M2	R1	H1
Vertical	Industry leadership		+		+	+	+	o	
	Industry fragmentation								+
	Vertical standards		+	+	+	+	+		o
Horizontal	Partner demand	o	+	+	+	+	+	+	+
	Expertise								
	- Technical	-		-	-	-	-	-	+
	- Conceptual			o	-	+	+	+	-
	Justification and ROI		+	+	+	+	+	+	+
	Management support			+		+		+	
	Performance					O		+	
	Vendor support								
	- Tools					-	-	-	-
	- API		+			-	o	-	
	Security	o	+	+	+	+	o	+	+

Vertical Factors

Vertical Standards Maturity

Participants from several cases mentioned the immaturity of vertical payload standards as an important challenge to the adoption of SOA. Although Web services can be developed and deployed using custom payload definitions, the availability of industry standards appears to be an important factor in the larger picture of realizing an effective SOA. A participant from organization M1, for example, mentioned that the lack of industry payload standards is inhibiting it from exposing functionality as a Web service because it is not clear which format would be appropriate for its potential business partners. A participant from organization M2 pointed out that payload definitions are a key challenge as current industry standards are immature and too basic to be useful. He further added that the organization itself is not in a position to provide the payload definitions to its business partners. This has to be accomplished through an industry consortium to gain the necessary acceptance. Particularly in industries that are not dominated by a few "big players" that can just push their definitions, the lack of vertical standards inhibit organizations to move forward with SOA on a larger scale. Different industries are at different stages in the process of forming consortia and developing vertical payload standards. As a result, the progress of SOA adoption can be expected to vary between industries based on the maturity of vertical payload standards.

Industry Leadership

While B2B interactions are only one aspect of an SOA, they have relevance regarding the adoption of SOA in general. There are several industries, such as the automotive and financial industry, in which a majority of participating businesses has to interact with a few big players. In this scenario, the adoption of a new technology largely depends on the leadership that the dominant organizations provide. A participant in the M2 case, for instance, pointed out that one large retailer that is a major customer of the manufacturer is currently focusing on AS2 rather than Web services. The organizations in the financial industry also provided evidence that major players have not yet moved from proprietary protocols to standard Web services. As one senior manager put it, "Our industry is not a leading edge industry. I think we are getting a little bit more aggressive, but we probably are just barely touching fast follower." As the power structures and technology leadership can be expected to vary between industries, so can the development of an interoperable service "ecosystem" and, thus, the adoption of SOA.

Industry Fragmentation and Inertia

The adoption of any new technology is generally more difficult in a highly fragmented industry with many relatively small sized businesses. This is illustrated in the case of organization H1. Many customers as well as some suppliers are very small organizations with limited IT resources and a lack of IT expertise. The adoption of new technologies, whether it was fax or the Web, has historically been slow. Although there are substantial benefits

for H1 to provide a standard interface (such as drastically reducing the number of different interfaces that need to be maintained), it will be difficult to persuade relatively small sized firms to adopt Web services, so that H1 could use them for their applications which leverage an SOA.

Horizontal Factors

Business Partner Demand

The lack of business partner demand for standard service-oriented interfaces is still an important inhibitor to its adoption. One participant suggested, "There are no blind dates in Web services," emphasizing that "old fashioned face-to-face agreements" are currently the only way an exchange with a partner occurs. While an SOA can focus on internal benefits, strong external demands from customers or suppliers make the justification for IT projects clearer and easier to convey to higher level decision makers. This sentiment was best captured by one participant who stated that "rather than being in mentality of 'If we build it, they will come' [it is] 'If they come, we will build it."

Availability of Expertise

The participants differentiated among the types of expertise that is necessary to develop services-based applications, including technical skills, conceptual skills, and tool skills. Technical skills, such as knowing an appropriate implementation language (e.g., Java or C#), or knowledge of the relevant standards (mainly WSDL and SOAP) were viewed as "just another technology to learn." However, "Probably no new skills would be required. It is only important to become familiar with the publish/subscribe paradigm and the standards," were not considered a major challenge by most participants. As multiple participants pointed out, the bigger issues are the conceptual changes and "change in mindset" involved in moving towards a highly distributed and service-oriented application architecture. This could be characterized best as a "mindshift" and may have significant implications on the ease of this transition for these participants [2].

Beyond the individual skills, the IT function of organizations face the challenge of developing the ability to effectively agree on standards and foster the reuse of components. Some participants further suggested that the IT function may also face changes as there will be a need for new roles (e.g., service librarian), new ownership and control structures, as well as new software development processes.

Justification and ROI

The issue of justifying and demonstrating a sufficient ROI for SOA was mentioned as a challenge by all but one organization. Common problems were the difficulty of finding an appropriate case to demonstrate the benefits and the obscurity or indirectness of some of the potential benefits. Therefore, many organizations were selecting projects that were more likely to achieve a desirable result (e.g., cost savings, code reduction), using the concept known as selecting the "low hanging fruit" [25]. As one participant from organization H1 pointed out, customers may not see the immediate advantages of services working behind the scenes and may view the introduction SOA related technologies as just another technology they need to adopt without resulting in clear immediate business benefits. The difficulty of linking SOA to immediate business benefits was also corroborated by statements from participants in organization R1. A participant from organization M2 mentioned that the current ROI is not sufficient for rapid adoption, as a service-oriented approach does not offer anything that matters to their business that cannot be achieved within the current IT architecture, albeit an architecture that is less flexible and probably more costly in the long run.

Management Awareness and Support

Several participants pointed out that SOA use on a larger scale would require a strategic mandate from upper management. Several participants noted that current software development priorities do not permit sufficient time and resources to seriously explore and assess the development of an SOA. Consequently, these participants suggested that with SOA, it is not so much "if" but "when" it makes sense to move towards SOA, given the specific organizational characteristics and business environment [28].

Performance of Services-based Applications

Performance was mentioned as a potential challenge in two cases. In the case of organization R1, some services would have to process information from several million rows of data from a database. Converting and sending this data as XML documents could further slow down applications. In another case, the sentiment was that an SOA may only add additional and arguably unnecessary layers that require expensive transformations between applications that could otherwise communicate in a native protocol. However, performance concerns have not been confirmed in actual production use or testing by any of the participating organizations.

Vendor Support for SOA and Web Services

The support for an SOA and its underlying technologies (i.e., Web services) by IT vendors can be a determining factor for moving towards a standards-based SOA. As one participant stated, "The way the […] tool is designed you're kind of forced […] to use certain archi-

tectures, and that's how the Web services end up in there." The increasing support for using Web services in development tools and for making them the preferred API for integration in packaged applications provides strong incentives for organizations to adopt Web services to the extent that developers may sometimes be "forced" to use them. While the use of Web services does not necessarily result in an SOA, the availability of standards-based service interfaces helps to close the technology gap and arguably makes the move to an SOA easier.

The participants with experience in developing applications in an SOA noted that the tool support is good. In fact, the existing tool support is viewed as a contributor for software development efficiencies, a key benefit associated with the use of services. It is important to pick the right tool, however, as the H1 case illustrates. The initial open source tool selected in this case was replaced with a commercial tool after it became clear that the open source tool was not able to correctly create valid WSDL documents from given C++ classes. A major thrust for moving towards an SOA is provided by the large Enterprise Systems vendors (e.g., Oracle or SAP) as they are incorporating support for an SOA into their current line of application products and tools. In the process of keeping their Enterprise Systems current, organizations using these systems will at some point have technology in place that supports - if not mandates - developing an SOA.

Security

Security, including confidentiality, integrity, and availability of information exchanged via Web services, is an issue that concerned all participating organizations. As one participant stated, "The fact that Web services are not fully defined yet is a reason why the adoption of Web services is taking so long." A member of one of the participating organizations in the financial industry recently stated that his organization views Web services as an opportunity to streamline and consequently improve security by using Web services in conjunction with the recent security standards. Security, however, was viewed by some participants as more of a business and standards problem rather than a technical problem. One participant pointed out that, "As an industry, we need to get serious about security. … Security is not a technology problem; security is a business problem. … The reality is, we should agree on a standard and implement it." Clearly, the perceived maturity of Web services security standards is a crucial element for the broader adoption of Web services and, thus, an SOA. Without a reasonable "peace of mind" when exposing Web services or when consuming external services, the availability of services will likely remain limited and not reach the critical mass necessary to realize a viable "service ecosystem" and, consequently, some of the key benefits associated with SOA services, such as reuse, flexibility, and manageability.

RELEVANCE FOR PRACTICE

This study on the challenges and impacts that organizations face in the process of adopting an SOA provides academics with a research framework on this current issue and practitioners with insights on key challenges of adoption. While service-oriented IT architecture is gaining increased attention in academia, particularly related to technical issues, the publication of research on the adoption of SOA in organizations is still sparse in peer-reviewed academic journals. This research addresses a timely and important topic on a leading edge practice, thus providing relevant academic research, which has been encouraged by eminent IS researchers [3][17][19]. We identify essential theory and literature and provide a model for examining the adoption of an SOA. The outcomes of this study can be applied to conduct further research on SOA adoption, particularly on the challenges of adoption.

Practitioners are provided with a rigorous assessment of actual cases and can obtain insights on key challenges and their importance. These findings should help IT professionals reconcile the diverse opinions on SOA asserted in the literature and ultimately help them to focus attention and resources on the key issues and create more effective information systems using SOA. Based on the most important challenges factors, we identified four main areas that an IT manager should assess in determining when and how to move towards an SOA. This knowledge may provide guidance for organizations that are in the process of adopting an SOA.

LIMITATIONS AND FUTURE RESEARCH

The findings of this study are a reflection of the experiences of eight organizations in multiple industries at a single point in time. As Lee and Baskerville [16] point out, it is possible to generalize from case study findings to theory, but the resulting theory as such has no generalizability beyond the given case. Organizations with different requirements and business drivers may follow a very different adoption path than the firms that we examined. The importance of the factors that we identified in this study may also vary over time as organizations learn and become more familiar with the technology. For instance, factors that were not revealed or were deemed unimportant in these cases may later become significant. We did

not conduct a formal investigation of inter-coder reliability in this study. While inter-coder reliability is sometimes reported in case-based research, the appropriateness of this measure has been challenged [1]. All research documents, however, were coded and reviewed by multiple researchers independently and consolidated during face-to-face sessions. These measures helped to reduce personal biases and to include differing viewpoints in our analysis process.

Further research will be necessary to substantiate our theoretical model. One approach is to develop a broader quantitative survey based on the theoretical model developed in this study. Employing another methodology may corroborate our findings and generate a richer picture of the challenges facing organizations adopting an SOA. A longitudinal perspective that examines the decision-making process of organizations over time could also be another fruitful avenue for further research that could give an even richer depiction of the challenges and impacts that organizations face in the process of adopting a service-oriented architecture.

CONCLUSIONS

Our case studies corroborate recent evidence that suggests that organizations are either implementing or considering the implementation of an SOA, but that substantial challenges persist. Some factors are universal for all organizations, while a number of vertical factors can be expected to differ between industries. Therefore, the pace and approach of adoption can be expected to vary between industries as well. For IT decision makers, it is important to be aware of and carefully assess these factors to make "mindful" adoption decisions [28]. Our research utilizes these context-specific factors that we identified to provide decision guidance for organizations pursuing an SOA.

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APPENDIX

Interview Guide

1. How are you involved in IT initiatives that involve Web services? Provide a brief overview of the current IT infrastructure, including key technology platforms and major applications. Independent from Web services, what are the major objectives that IT tries to accomplish? How do they relate to overall business objectives?
2. Please provide us with an overview of current IT initiatives that involve Web services. This may include a summary of the technology platforms and tools used for development, the usage patterns of Web services (provider/consumer, internal/external), the project scope, and the project status (exploration, planning, testing, production).
3. Based on your personal involvement and experience with Web services, choose a key project of the projects mentioned above (even if it is only an exploratory or planned project) and describe it in more detail. This description may include further information about the motivation, the technology and tools used in the project, the current status, and timeline.
4. What do you see as the key benefits of Web services? What are other important impacts that Web services has on software development, the IT infrastructure, and perhaps the organization as a whole?
5. What are the key challenges encountered in the process of adopting Web services? Please describe the technological or organizational challenges you encountered.
6. What do you see as important steps that need to be taken or issues that need to be resolved to overcome the challenges mentioned above?
7. What solutions has your organization developed to – at least temporarily – handle the shortcomings of current Web services? This may include workarounds and custom solutions, as well as decisions to not adopt Web services at this point in time
8. If you were to give some advice to a senior manager who was considering the adoption of Web services technology, what would be the three most important lessons you have learned in the process of evaluating, developing, or using Web services?