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The Interplay between Cloud-based SOA and IT Departments: Research Directions

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ABSTRACT

Cloud-based SOA refers to an application architecture within which all functionalities are defined as independent services with cloud-based APIs that can be used to leverage external computing resources through ubiquitous Internet access. This paper uses cloud-based SOA as a new form of IT-enabled enterprise transformation to reconceptualize the roles of IT departments. A proposed conceptual framework argues that IT departments and cloud-based SOA are mutually influenced. Upon reviewing relevant literature, this paper suggests that research should reexamine critical success factors in cloud-based SOA implementations and investigate influences of cloud-based SOA implementations in the reconstruction of IT departments. Research questions and propositions are developed to guide research in this area.

Keywords

IT departments, cloud computing, service oriented architecture, IT-enabled enterprise transformation.

INTRODUCTION

Globalization, mergers and acquisitions, tremendous amounts of electronic data, and ever-changing customer demands have created new challenges for information processing. These challenges require organizations to rethink their business models that are often facilitated by IT innovations. Cloud computing and Service Oriented Architecture (SOA) are two emerging paradigms and together they represent a promising solution for a variety of information-processing challenges in modern organizations.

Cloud computing is defined by the National Institute of Standards and Technology as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." A service-oriented architecture (SOA) is defined as "an application architecture within which all functions are independent services with well-defined invokable interfaces, which can be called in defined sequences to form business process" (Channabasavaiah et al. 2003). Cloud computing and SOA are closely related concepts. They have a large degree of overlaps in rationales, principles, challenges and advantages. This study defines cloud-based SOA as an application architecture within which all functionalities are defined as independent services with cloud-based APIs that can be used to leverage external computing resources through ubiquitous Internet access.

Cloud-based SOA is essentially an IT-enabled enterprise transformation. It is a new form of IT innovation. Cloud-based SOA represents a new research area with great potential for theory development and theory extension. As a new trend in IT industry, cloud-based SOA creates both opportunities and challenges for IT departments during the enterprise-wide transformation of business processes and services. This study proposes a research agenda to examine the duality of IT departments in affecting and being affected by IT-enabled enterprise transformation using cloud-based SOA as a research vehicle. The purpose of this study is to survey relevant research streams, to develop a conceptual framework, and to provide directions for future research in this area.

This paper proceeds as follows. The next section proposes a conceptual framework to understand the interaction between IT departments and cloud-based SOA. Guided by the framework, the paper suggests two research themes—critical success factors of cloud-based SOA projects and the implications of cloud-based SOA implementation on changes in IT departments. The paper concludes with a summary of key points.

CONCEPTUAL FRAMEWORK

Much of the IS literature focuses on investigating the role of IT departments in IT innovation implementations. Expertise of IT staff and technology quality are often used as explanatory factors for performance (Barthélemy and Geyer 2005; Byrd and Davidson 2003; Cragg et al. 2002; Melville et al. 2004; Ross and Weill 2002). In these cases, IT department is tasked to assemble resources, to facilitate processes, and to pay continual attention on the key factors that might influence the success of IT implementation. More recently, another research stream in IT innovation has emerged to study a wide range of IT-enabled organizational changes in business performance, competitive advantage, organizational structure, culture and management style (Kettinger et al. 1997; Sabherwal et al. 2001; Sharif et al. 2004). Yet, little is known whether and how IT departments may be shaped by an IT innovation.

This study attempts to bring together these two previously isolated research streams into one unified conceptual framework in which IT departments and cloud-based SOA are connected in a feedback loop (Figure 1). This framework proposes a reconceptualization of the role of IT departments in a new research context and suggests that the dynamics of influence between IT department and cloud-based SOA should be jointly studied. On the one hand, although cloud-based SOA is a strategic initiative, it is often the case that an IT department spearheads and implements such an initiative. Naturally, one of the important questions is what are the critical factors that IT departments should pay special attention to in order to make the implementation successful. On the other hand, investigation of the effect of cloud-based SOA implementations on IT departments is another relevant research area. We argue that IT departments can be impacted and reconstructed in several significant aspects because of the implementation of cloud-based SOA.

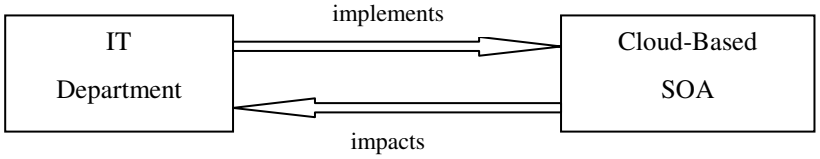

Figure 1. An Integrative Research Framework

This broad research framework, as a matter of fact, can be extended to study a wide range of IT innovations in organizations. First, researchers and practitioners are eager to understand factors that may influence a successful implementation of an enterprise-wide IT initiative before and during IT implementation. Second, researchers and practitioners are also interested in understanding the impacts of IT initiatives on organizations and IT departments during and after IT innovation implementation.

LITERATURE REVIEW

A variety of issues related to cloud computing and SOA have been widely discussed in online forums, trade magazines, industry reports, and professional trade journals. To date, little research or formal theorizing can be found with respect to these topics in the literature, largely because cloud computing and SOA are relatively new phenomena. Therefore, the literature review below broadly discusses IT projects that are relevant to our understanding of cloud computing and SOA.

Theme 1: Critical Success Factors (CSFs) in Enterprise-wide IT Projects

The concept of critical success factors (CSFs) was introduced by Rockart (1979) as a number of areas in which desirable results will ensure successful competitive performance for an organization, or areas where things must go right for the business to flourish. Over the past decade, a considerable amount of research has been conducted in CSFs in various IT contexts such as ERP implementations, enterprise application integration, and other IT implementations.

CSFs of ERP Implementation

CSFs of ERP implementation have been extensively studied using a number of methodologies such as meta-analysis, survey, and case studies. Despite the slightly different rankings, the most prominent CSFs reported in the literature are top management support, a clear understanding of strategic objectives, strong project management, project team competence, user training and education, interdepartmental or multi-site cooperation, and evaluation of performance (Poon et al. 2001; Somers et al. 2001; Umble et al. 2003).

Researchers often classify CSFs into different categories. For example, Nah et al. (2001) classified eleven CSFs into five phases according to Markus and Tanis' ERP life cycle model (Markus et al. 2000). Besides the work of CSF identification and categorization, researchers also find that CSFs are not a static concept and may change across the lifecycle of ERP

implementation (Plant et al. 2007; Somers et al. 2001). For example, top management support, clear goals and objectives together with strong interdepartmental communication are critical in the early lifecycle stages. In the final implementation stage, the emphasis will be shifted to a convergence of top management support, project team competence and interdepartmental cooperation (Plant et al. 2007).

In contrast with a life-cycle based approach, Holland and Light (1999) classified CSFs of ERP into strategic and tactical factors. The strategic factors include legacy system, business vision, ERP strategy, top management support, project schedule and plans. The tactical factors are client consultation, personnel, software configuration, client acceptance, monitoring and feedback, communication, and trouble shooting.

Yet, some researchers choose to focus on certain aspects of ERP implementation instead of developing a gamut of CSFs. Li (1997) emphasized the role of human factors in successful information system projects. He pointed out the significant discrepancies of the perceptions of the IS success factors between IS personnel and users. Hong and Kim (2002) suggested that ERP implementation success depends significantly on the organizational fit of ERP and certain contingencies such as ERP adoption level, process adoption level, and organizational resistance. Robey et al. (2002) focused on the dialectical learning issues in implementing ERP systems and argued for a need to overcome two types of knowledge barriers: those associated with the configuration of the ERP package and those associated with the assimilation of new work processes. In addition, the dynamics of ERP implementation has been revealed in several studies (Akkermans et al. 2002; Delone et al. 2003). The key finding is that CSFs are highly correlated in a reinforcing manner.

CSFs of EAI and BPR

Enterprise application integration (EAI) and business process reengineering (BPR) provide another rich context for research in CSFs of IT projects. System integration is different from ERP implementation in terms of the implementation scope and nature. Despite a few similarities (e.g. top management support, project management, and training), the CSFs of ERP may not directly apply to EAI.

Lam (2005) emphasized the importance of the selection of the right EAI tool, technology planning, and enterprise architecture. He also suggested that business integration needs to precede technology integration. In particular, EAI requires specific personnel skills and expertise and the importance of adapter, especially the customer adapter, should not be overlooked.

Another critical feature to business process integration process is the different perspectives of business managers and IT managers. The success of IT alignment requires different yet convergent perspectives of IT managers and business managers (Burn et al. 2000). By emphasizing social factors that influence the alignment between business and information technology objectives, Reich and Benbasat (2000) argued that shared domain knowledge between IT personnel and business executives, communication between IT staff and business executives, and connections between IT and business planning processes are crucial CSFs of business process integration.

To sum up, we categorize CSFs of enterprise-wide IT projects in the literature, based on the five dimensions from Al-Mashari and Zairi (1999). The results are shown in Table 1. It is noted that the factors summarized under each category include, but are not limited to, the factors used in Al-Mashari and Zairi (1999).

Category	Factors	References
Change management and culture	Cultural adjustment, resistance, revising reward and motivation system, empowerment, effective communication, human involvement, training and education, receptiveness to change.	Ahmad et al. 2007; Cooper et al. 1995; Davenport 1993; Hammer et al. 1995; Huq et al. 2006; Sayer et al. 1997; Zairi et al. 1995
Management competence	Committed leadership, championship and sponsorship, risk management	Attaran 2004; Clemons 1995; Cooper et al. 1995; Grover et al. 1997; Harrison et al. 1993
Organizational structure	Job integration approach, project teams, job definition, responsibility relocation	Brynjolfsson et al. 1997; Grant 2002; Hasselbring 2000; Orman 1998
Planning and project management	Adequate resources, appropriate use of methodology, external orientation and learning, effective use of consultant, effective process redesign	Grover et al. 1995; Harrison et al. 1993; Sarker et al. 2002; Willcocks et al. 1995
IT infrastructure	Alignment of IT infrastructure and strategy, IT investment and sourcing decisions, measurement of IT effectiveness, IT integration, legacy system, IT competency.	Brancheau et al. 1996; Broadbent et al. 1997; Earl 1996; Kettinger et al. 1997; Reich et al. 2000; Zairi et al. 1995

Table 1. CSFs of Enterprise-Wide IT Projects

Theme 2: Implications of IT initiatives on Organizational Change

A preliminary survey of the literature shows that the impact of IT initiatives on IT departments has not been well studied. We believe that a review of implications of IT initiatives on organizations as a whole is a useful first step to develop some insights on this topic.

Research efforts have been made to understand organizational impacts of IT innovation at the business performance level and at the strategic level. Some of business performance improvements from IT innovations are the quality and timeliness of intelligence and decision making, production, communication and integration of information, strategic planning, and business flexibility (Dennis et al. 1997; Ordanini et al. 2010; Sabherwal et al. 2001). At the strategic level, IT is viewed as a critical force in shaping organizations with respect to the transformation of competitive landscape, firm structures, and firm boundaries (Kambil et al. 1994; Neirotti et al. 2007).

EAI and BPR are two technological innovations that have often been used to showcase how IT can effectively transform organizations. EAI is a broad concept which covers business process, business models and organizational transformation (Sharif et al. 2004). Sharif et al. (2004) suggested that an evaluation of the impact of EAI should adopt a stakeholder-based view. This view addresses the attributes of the underlying technology and also other aspects of EAI including the capacity for the organization to learn and adopt the integrated information management practices, and the analysis of decision-making flow. Similarly, Kambil and Short (1994) found that electronic integration dramatically alters the business network of small businesses by leveraging the capabilities of various other organizations and previously separate business networks through contracts. These views imply a shift of the focus from intra-organizational components to inter-organizational components.

BPR is another rich research context for process change. It involves attempts to transform the organizational subsystems of management (style, values, and measures), people (skills, roles, and culture), information technology (data, knowledge, decision, and modeling) and organizational structures (informal and formal structure, power distribution, and team and coordination mechanisms) (Kettinger et al. 1997). Some business impacts of BPR include cost reduction, efficient processes, rapid development of revenue-based services, closer relationships with suppliers, and new business opportunities (Broadbent et al. 1999). BPR also resulted in cultural and behavioral transformation. Many of the BRP practices that failed or were stalled can be attributed to inadequate attention to individual behavior and the collective changes (Bieberstein et al. 2005). The influences of BPR in this regard include, for example, fostering teamwork, matching skills and roles to services, new work styles, and new measurement metrics (Bieberstein et al. 2005).

SUGGESTIONS FOR CLOUD-BASED SOA RESEARCH

Using the integrative model in Figure 1 as a lens through which to interpret the findings from previous studies and to illumine research directions in the new area of cloud computing and SOA, we identify two sets of research questions corresponding to the two research areas reviewed above (See Table 2). Theories are developed in response to each set of research questions.

Themes	Research Questions
Critical success factors	*1. What are the CSFs of cloud-based SOA implementation?* *2. How are the individual CSFs correlated?*
Impacts of Cloud-based SOA implementation on IT departments	*3. In which aspects are IT departments shaped by cloud-based SOA implementation?* *4. To what extent are IT departments shaped by cloud-based SOA implementation?*

Table 2. Research Questions

A Theory of CSFs of Cloud-based SOA Implementation

Cloud-based SOA has three features that distinguish it from other IT innovations. First, cloud-based SOA leverages external hardware and software resources provided by third-party technology vendors. Unlike many traditional IS projects, the utilization of cloud services is no longer an intra-organizational matter. Second, cloud-based SOA implementation usually involves rebuilding a system from existing components, maximizing service reuse and eliminating redundant implementations (Bieberstein et al. 2005). Third, cloud-based SOA is dynamic and adaptive in a manner that new services and software components can be easily added or changed. These new features make cloud-based SOA implementation a novel research context, which justifies a reexamination of CSFs.

The preliminary step to answer the first research question is to outline an integrated list of CSF dimensions. Drawing on findings from previous studies in ERP, EAI and other IT projects, as well as the unique characteristics of cloud-based SOA we propose a theoretical model that highlights five CSF dimensions in Figure 2.

Top management support is a strategic-level dimension identified from many previous studies. It is viewed to be highly important because cloud-based SOA is often a large-scale, organization-wide strategic initiative. The implementation of SOA, at its essence, is about breaking down the current system into independent functionalities and loosely coupling them with service interfaces. The change in business routines may cause resistance, responsibility relocation, job redefinition and some other side effects. These issues require an effective *change management*[1] to achieve successful outcomes. *Project management* involves developing sound plans, assembling resources, using right tools, and more importantly, having appropriate redesign of business processes. The fact that organizations do not own and maintain, at least partially, computing resources in house, calls for strong *partnership management* to work with vendors in avoiding misunderstanding and dealing with security and reliability issues. *Organizational attribute*[2] describes a set of organization-related characteristics that might influence the success of the implementation. Factors under this domain may include information intensity, IT readiness, business processes and business strategy.

[1] We don't include "organizational structure" used in Al-Mashari and Zairi's CSF model because organizational structure is a static concept, and might be confusing when it applies to the evolving transformation from an old structure to the new one. In the cloud-based SOA, we want to emphasize change management which is a dynamic process that may involve many aspects of changes in organizational structure, such as job redefinition and responsibility relocation.

[2] Organizational attribute is a broader category than IT infrastructure used in Al-Mashari and Zairi's CSF model. The underlying logic lies in the inquiry of the question: Which types of organization are more likely to implement cloud-based SOA? *Information intensity* describes whether an organization requires intensive information processing. *IT readiness* describes whether an organization has sufficient resources (in hardware and human resources) for implementing cloud-based SOA. *Business process* is a factor indicating to which extent business processes may be broken down into modules or loosely coupled. *Business strategy* describes to what extent information technology is viewed as critical to maintain the competitive advantage of the organization.

One may probably notice that these five dimensions (top management support, change management, project management, partnership management, and organizational attribute) have some overlap with the CSF presented in Table 1. That is because cloud-based SOA shares some attributes with other forms of IT initiatives. It is also worth mentioning that nascent research areas such as cloud-based SOA usually require open-ended inquires and learning orientation to generate new theories (Edmondson et al. 2007). Precise conceptualizations of new concepts, constructs or patterns prior to data access should be avoided because such practices would risk ruling out unexpected but interesting findings and thereby jeopardizing new knowledge generation. The purpose of this study is to develop suggestive theories rather than testing existing theories. We intend to offer a preliminary framework that is helpful to guide research in cloud-based SOA implementations.

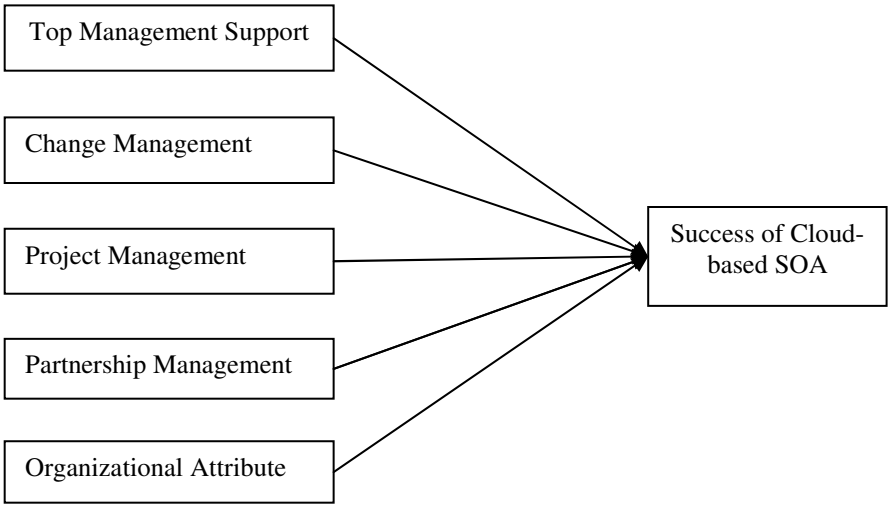

Figure 2. A Theoretical Model of CSFs for Cloud-Based SOA Implementation

Impacts of Cloud-Based SOA on IT Departments

The dual role of technology in organizations was examined by Orlikowski (1992), who argued that technology not only serves as an independent external factor to influence human and organizations but also a dependent product subject to strategic choices, human actions and design. Since then, research efforts have been dedicated to studying the changing roles and responsibilities of IT departments from IT innovations (Weiss et al. 2003). As IT is increasingly leveraged to successfully transform business processes and services, the role of IT departments has evolved from a service provider to a strategic partner (Van Grembergen et al. 2003; Venkatraman 1999). IT leaders now take more responsibility in strategic alignment between IT and business and in change management (Boynton et al. 1992; Weiss et al. 2003). Meanwhile, the role of IT staff tends to be evolved into areas related to communication, business problem solving, and understanding of political and cultural issues of end users (Weiss et al. 2003). The evolving technological innovations bring about several challenges to IT departments and IT professionals. These challenges include the need to achieve the economy of scale in the IT department when a merger is completed (De Haes et al. 2005) and to maintain technological competence (Gallivan 2004; Schambach et al. 2002). The findings from previous research are certainly useful in directing research in the area of cloud computing and SOA. However, there is a need for more research to examine the explanatory power of these constructs in a new context of cloud-based SOA.

As discussed earlier, cloud-based SOA involves leveraging external resources and outsourcing some IT functionalities that were originally assumed to be maintained in house. Cloud-based SOA is an enterprise-wide initiative, suggesting that IT departments will be more involved in strategic planning on business process rebuilding. These unique attributes of cloud-based SOA may cause several changes of IT departments. We conjecture that these changes may include IT functionality, role and responsibility, job redefinition, IT professional expertise, CIO leadership, and employee turnover. Corresponding brief propositions are developed for each of these change domains (Table 3).

Domains	Propositions
IT functionality	The functionality of IT departments will be shaped toward providing IT services through reusing existing system components and leveraging scalable and flexible computing resources from vendors.
Role	IT departments will act not only as a technology service provider, but also as a strategic partner that assumes responsibilities in business technology alignment as well as maintaining a working partnership with vendors.
Job redefinition	IT jobs will have less involvement in in-house software development, and more involvement in system design, resource allocation, and Service Level Agreement (SLA) management.
Professional expertise	Expertise of IT professionals will be comprised of skills in understanding business requirements, redesigning business processes, facilitating inter-departmental communications, as well as knowledge of interoperability, security and system scalability.
CIO leadership	CIO will be more involved with organization's strategic planning.
Employee Turnover	A higher employee turnover may occur because cloud-based SOA implementation requires different expertise and involves job redefinition.

Table 3. Propositions of the Impacts of Cloud-based SOA on IT Departments

CONCLUSION

Cloud-based SOA, a new form of IT innovations that enables enterprise transformation, provides an exciting context for theory development. This study contends that IT departments play dual roles in an IT-enabled enterprise transformation. An integrative research model was developed to show that IT departments affect and are affected by the implementation of cloud-based SOA.

In this review, we identified and surveyed two related research areas: 1) critical success factors of IT innovations, and 2) organizational change resulting from IT innovations. Drawing on the results from the previous work, we made important suggestions for cloud-based SOA research. In particular, we encourage research to examine CSFs for cloud-based SOA implementations. In addition, an investigation of the implications of cloud-based SOA on IT departments is another important topic to better understand the changing role of IT departments and IT professionals.

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