EFFECTIVELY MANAGING INFORMATION SYSTEMS ARCHITECTURE STANDARDS: AN INTRA-ORGANIZATION PERSPECTIVE

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ABSTRACT

Most standards research focus on standardization of Information and Communication Technology (ICT) standards across an industry. Prior research has not focused on standards management issues within organizations. It is important for research on ICT standards to consider the issue of how organizations should effectively manage their internal standards. Internal ICT standards are manifested as information systems (IS) architecture standards and frameworks. We differentiate between infrastructure architecture standards and integration architecture standards. We argue that it is important to differentiate between these two types of architecture standards, because of the differences in the focus, scope, and benefits of infrastructure and integration architecture. We make use of the information processing theory to make hypotheses about how the structure and organization of the architecture team and inter-unit coordination and control mechanisms are expected to differ for effective management of integration and infrastructure architecture. For infrastructure architecture standards, the goals and benefits are obvious to the IT department, but not necessarily so for the individual business units. While using the standards will provide long-term benefits to the organization as a whole, each business unit may not observe a direct benefit from using the standards in the short term. We hypothesize that to effectively manage infrastructure architecture standards, projects should be IT driven, architecture teams should be managed centrally, and the necessary inter-unit coordination and control processes should be in place to govern the interactions of architects and IT operations personnel. On the other hand, integration architecture standards provide business-focused benefits, but are more costly, more complex to manage and require more business involvement. We hypothesize that to effectively manage integration architecture standards, projects should be driven by the business goals of one or more lines of business, architecture teams should have a matrix structure, and the necessary coordination mechanisms

should be in place to govern the interactions of architects, IT development personnel and line management. In both cases, organizations should ensure that their architects have the necessary experience working on projects that their architecture standards have an impact on. To test our hypotheses, we are conducting a multi-method study that includes both the qualitative case-study method and the quantitative survey method.

Keywords: IS Architecture; IS Integration; Information Infrastructure; Standards.

INTRODUCTION

With the proliferation of different types of technology, the role of standards in managing and developing information and communications technologies (ICT) is becoming increasingly salient. While it is important to examine the role of industry wide standards or open standards in affecting the management of information systems (Chau and Tam, 1997; Chen, 2003; Kahin and Abbate, 1995; Sirbu and Zwimpfer, 1985), research on ICT standards also need to consider the issue of how organizations should effectively manage their internal standards. Internal ICT standards are manifested as information systems (IS) architecture standards and frameworks. IS architecture is a blueprint for an overall portfolio of information resources within an organization (Zachman, 1987). Information resources represented by an IS architecture include data, functions, hardware, system and application software, network, etc.

Managing IS architecture standards has been identified as a critical IS management issue facing IS executives (Niederman, Brancheau, and Wetherbe, 1991; Segars and Grover, 1996). While there are many different types of IS architecture standards that can be used at different levels within an organization (at the project, department, business unit, or organizational level), we focus on enterprise level IS architecture standards. We define an enterprise IS architecture as "the organizing logic for applications, data, and infrastructure technologies, as captured in a set of policies and technical choices, intended to enable the firm's business strategy" (Ross, 2003, pp. 32). Organizations that build enterprise architecture institutionalize within the enterprise a governance mechanism that enables a holistic view across the enterprise of IT and how it supports business. This distinguishes enterprise IS architecture from project-centric application architecture, that may lead to the optimization of individual solutions, and yet pay no attention to optimizing the entire enterprise. The focus on having IS enterprise architecture standards to govern IS management sets enterprise architecture apart from large IT projects that happen to be of enterprise-wide scope.

Without effective enterprise architecture, applications and systems are designed to local optima which, while achieving the objectives of individual areas (lines of business, or individual agencies), do not necessarily advance the goals of the enterprise. Further, building to a local optimum generates a variety of constraints at the boundary of the local system. These constraints increase cost and time within the IT organization and, to a much greater degree, across the enterprise. To better align the organization's long term and business objectives to the IT plans and capabilities of the organization, IS enterprise architecture standards act as a "boundary object" (Carlile, 2002; Star, 1989) to align IT to the changing needs of the business and changing technology capabilities. A "boundary object" establishes a shared context between two or more parties (Star, 1989), and provides a concrete means for individuals to specify and learn about their differences and dependencies across a given boundary (Carlile, 2002).

Effective management of enterprise architecture standards can provide many cost and efficiency advantages in the organization. By standardizing across different technologies, vendors, platforms, as well as services and application architecture, organizations can reduce

the complexity of their operations, reduce the number of skills required to maintain their IT products, reduce the amount of waste and replication going on within the organization, and enable reuse. These can lead to lower cost and higher efficiency, and also provide organizations with better ability to plan for the future with greater flexibility in their ability to support new functions and better scalability of existing functions. Effective management of enterprise architecture standards also provide the organization with capabilities that were previously not available, more strategic uses of IT, and even competitive differentiation. For example, it could allow an organization to integrate with strategic partners, or enable competitive use of enterprise data such as better information about customers, their inventory, or the success of their marketing tactics.

Despite the advantages, few organizations have been able to reap all the benefits from using IS enterprise architecture standards (Kim and Everest, 1994). Given the variations in the ability of organizations to effectively manage and reap the benefits of managing enterprise architecture standards (Ross, 2003), it is important to determine what are the key factors affecting an organization's ability to effectively manage their IS enterprise architecture standards.

Some prior studies have examined organizations' experiences in implementing enterprise IS architecture standards (e.g. Brancheau and Wetherbe, 1986; Kim and Everest, 1994; Periasamy and Feeny, 1997; Ross, 2003). Several studies have also examined the problems and issues surrounding the use of Strategic Data Planning (SDP), a formalized, top-down, data centered planning approach that builds a model of the enterprise to identify and implement an integrated set of information systems that will meet the needs of the business (e.g. Earl, 1993; Goodhue, Kirsch, Quillard, and Wybo, 1992; Segars and Grover, 1998; Shanks, 1997). Most of this prior research uses case studies to identify the issues surrounding the management of enterprise architecture standards. While these case studies provide useful insights (e.g. scope of architecture standards is too wide; inability to balance long term objectives with short term requirements), none of them have systematically identified and investigated the key factors to the successful management of enterprise architecture standards and they have yet to systematically identify the underlying factors driving these problems (e.g. *why* organizations tend to set architecture standards that are too wide in scope).

Part of the problem is that current research tends to view IS architecture development as more of a one-time planning process (e.g. as advocated by the SDP methodology) rather than an ongoing process. Enterprise architecture, by definition, plays an integrating role in the enterprise. It is not a one-time exercise, but rather it is an ongoing effort within the organization to attempt to rationalize, integrate, and optimize the IT capability within an organization across many projects and business units. Hence, the critical success factors in building an enterprise architecture must focus on the structure, process, and governing mechanisms within the organization for building an enterprise architecture. To this end, we need to draw from organizational theory and apply it to the context of enterprise architecture in order for us to better understand what types of structure, processes and mechanisms organizations need to have in place to effectively manage enterprise architecture standards.

INFRASTRUCTURE VS. INTEGRATION ARCHITECTURE

There is no universally accepted definition of IS architecture (Kim and Everest, 1994; Ross, 2003). Much confusion surrounds the information systems architecture concept (Kim and Everest, 1994). Zachman (1987) first introduced the framework of IS architecture as a two-way matrix consisting of different views and different information sources. Since then, several studies have tried to further clarify the concepts of an IS architecture (Hamilton, 1999; Kim and Everest, 1994; Ross, 2003; Sowa and Zachman, 1992). Common across the various

conceptualizations of IS architecture, however, is the theme of organizing the computing resources in the organization, which consists of data, applications, and infrastructure, to enable a firm's business strategy.

There is consensus in the literature that there are two different sets of IS decisions (Brown and Magill, 1998; Brown and Magill, 1994; Olson and Chervany, 1980). One set concerns computer and communications/network operations and infrastructure planning activities. The second set is focused on systems development, including application planning, software acquisition and maintenance (Brown and Magill, 1998). Similarly, Hamilton (1999) distinguished between inter-working at the information technology infrastructural level of networks, computers and operating software, and inter-working at the applications level dealing with organizational business processes and information handling. Accordingly, we make a distinction between infrastructure architecture and integration architecture standards.

Infrastructure architecture refers to the standards and policies created to define the computing technology infrastructure for the enterprise. It establishes technology standards to limit technology choice, to reduce the number of platforms supported, and to define a set of computing resources that organizations manage. This standardization is expected to significantly reduce the number of vendor packages and infrastructure services that perform similar functions (Ross, 2003). Integration architecture refers to the standards and policies created to define the means by which business services, events and information are defined and accessed by the enterprise. It consists of a set of architectural components, such as data, processes, and event models, application architecture and service-oriented architectures (Brown, Johnston, and Kelly, 2003) that specify how different data, processes, and applications relate to each other across the enterprise. As the integration architecture standards become more completely defined, the enterprise evolves from an application programming interface (API) based integration model to an integration model that leverages shared data and services across different applications. Programming an interface for each application system that needs to interact with another system may solve the short-term transaction processing and data integration problem, but it becomes cumbersome to manage as the number of applications and the number of interfaces between the applications increases exponentially. On the other hand, an integration model that leverages shared data and services across different applications would define set of data and services that is common across different business processes. This would allow the organization to have better integration of data and transaction processing in the long term and better ability to scale its operations and support new functionality as the number of applications and functions required increase. Both types of architecture standards are required to effectively manage shared resources among different lines of businesses in the organization. However, it is important to differentiate between infrastructure and integration architecture because these two types of architecture have different characteristics, focus, scope, and benefits. Table 1 lists the key differences between the infrastructure and integration architecture standards.

Table 1. Key differences between the infrastructure and integration architecture standards

	Infrastructure Architecture	Integration Architecture
Focus	Providing common IT platforms, networks, and computing resources	Providing interfaces into and integration of business unit capabilities and information
Scope	Wide and heterogeneous community of users, or entire enterprise	For a limited and focused set of business services, prioritized by business value
Key metrics	Efficiency, cost	Cost and enablement of new business capabilities
Driver (champion) within organization	IT organization (at CIO/CTO level)	Corporate sponsorship for enterprise integration, executive sponsorship within each business unit
Comparable model	Public infrastructure provided by government	Business contracting

MANAGING INFRASTRUCTURE ARCHITECTURE

While the scope of influence for enterprise infrastructure architecture is usually wide, affecting a heterogeneous community of users and IT departments across different business units in the entire enterprise, different business units within the organization usually require the same infrastructure services (Broadbent, Weill, and St. Clair, 1999). Infrastructure services and architecture standards are usually not specific to the requirements of particular business units. There is thus less of a need for deep business insights from the individual business units, and more of a need for the organization's generic IT capabilities to be applied to the management of infrastructure architecture. The primary stakeholders are the IT personnel (in corporate IT or in the business units). The business analysts and line management play a secondary role. This indicates that the infrastructure architecture standards need to be driven by the unit(s) within the organization that constitute the source of IT knowledge, and these unit(s) are typically under the auspices of the CIO or CTO.

Since the goals and benefits from using enterprise infrastructure architecture are IT centric, and often lack the specificity of benefits that can be attributable to each business unit in the short term, the latter may not observe a direct benefit from investing significant resources in leading or participating in the management infrastructure architecture standards, even though there may be long-term benefits to the organization as a whole. Managing infrastructure architecture standards can thus be viewed similarly to managing public goods. To manage public goods, there should be a central authority (e.g. the government) who would take into consideration the welfare of the whole community when making investment and management decisions. Infrastructure architecture standards should, similarly, be driven by the overall long-term goals and objectives of the organization focusing on IT cost, efficiency, reliability and future IT capacity of the organization. If infrastructure architecture standards management is driven solely by the goals of individual business units, the long term sharing requirements for the organization as a whole will be neglected and there would be a lack of consideration of the shared needs and lack of cooperation between different lines of businesses. This would be reflected in the frequent replications of infrastructure services and heterogeneity in IT infrastructure, thus resulting in higher IT costs and reduced integration across different lines of business. This indicates that the infrastructure architecture standards need to be driven by a centralized organization, independent of the business units.

MANAGING INTEGRATION ARCHITECTURE

On the other hand, the scope of influence for enterprise integration architectures is typically limited or focused on a set of business services (e.g. related to customer relationship management, or supplier relationship management). The enterprise integration architecture concerns the integration of application systems and data, which tend to be more specific to individual business units. Hence management of integration standards need to take into account the specific requirements of each business unit, and require the inputs of business analysts and line management who are knowledgeable about the strategy, functions, data, and environment of each business unit.

Managing integration architecture standards is similar to managing business contracts, as integration architecture is a predefined agreement among business units to share application services and data in a specified manner. Managing a business contract require that there are shared values or benefits to all parties of the contract. Similarly, the scope of influence for enterprise integration architectures is typically more specific to and closely aligned with the goals of one or more business units, and tends to be focused on a set of business services. Business input and buy-in therefore becomes critical for the management of integration architecture and individual business units have a greater need to ensure greater control of the management of integration architecture standards.

IMPLICATIONS FOR ORGANIZATIONAL STRUCTURE, PROCESSES, AND MECHANISMS

The differences in the characteristics of these two types of enterprise architecture highlight the need for different levels of information exchange and collaboration between the architecture team and the business units and the IT department. According to the information processing theory, organizations seek to develop strategies and structures that enable them to match their information-processing capabilities with the information-processing requirements of their tasks (Daft and Lengel, 1984). Different task requirements should be handled by using the appropriate structure and mechanisms regulating the interactions between business units. Effective information processing includes the collection of appropriate information, the movement of information in a timely fashion, and its transmission without distortion. Structural characteristics range from the extent of formalization, centralization, leadership style, degree of participation, lateral and vertical communication, to distribution of power and control (Burns and Stalker, 1961; Comstock and Scott, 1977; Mohr, 1971).

It is the key thesis of this paper that the different characteristics of infrastructure and integration architecture influence the type of organizational unit structure, and the formalization and extent of inter-unit coordination and control mechanisms required to effectively manage these two types of architecture standards. We predict that these structural features will be manifested as the organization structure of the architecture team, the formalization of participation of various stakeholders in different standards management processes, the types of stakeholders involved in these processes, and the mechanisms available to provide architects with the necessary knowledge and experience to work effectively. In the following sections, we first define what we mean by effective management of architecture standards for both infrastructure and integration architecture standards. Then, we present our hypotheses about how the structure and mechanisms to effectively manage these standards are expected to differ, and the supporting arguments. Figure 1 shows our overall research model.

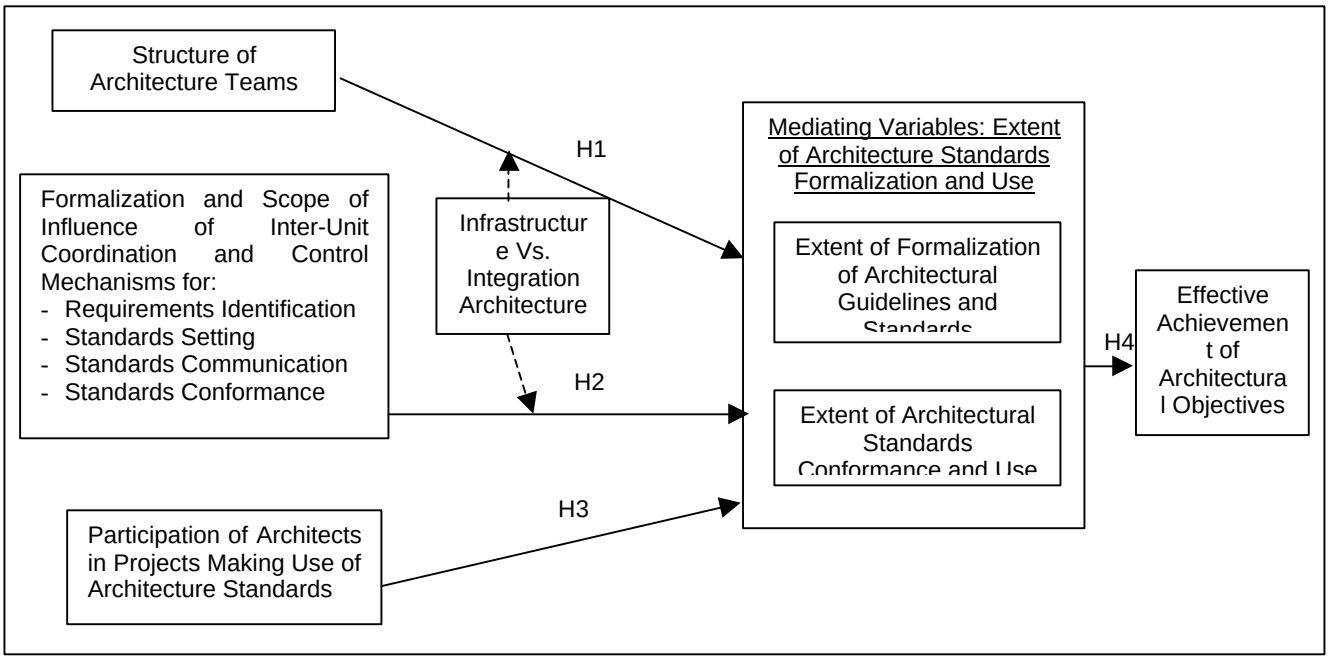

Figure 1. Overall Research Model

HYPOTHESES

EFFECTIVE MANAGEMENT OF ENTERPRISE ARCHITECTURE STANDARDS

Enterprise architecture standards can be expected to provide many benefits and outcomes to the organization. Effective management of infrastructure architecture can result in lower infrastructure cost and provide greater flexibility and reliability in meeting current and future demands and functionality. Effective management of integration architecture can result in lower maintenance and development cost, faster time to market of new products and services, better ability to integrate with strategic partners, and the better management of information resources in the organization. While these are potential benefits of architecture standards, we also recognize that these outcomes are affected by many other factors. For example, development and maintenance cost may be the outcome of other development conditions and factors (e.g. skills and experience of software development and maintenance teams) that we are not measuring in the scope of our study. Hence, we identify the key objectives of infrastructure and integration architecture standards in organizations, and examine the extent to which each organization has successfully achieved each of these objectives as a measure of their effectiveness in managing each type of architecture standards.

We identified three key objectives of infrastructure architecture standards management: to reduce redundancy of infrastructure services provided by different IT groups, to reduce heterogeneity of infrastructure components across lines of business, and to ensure enterprise system reliability, availability, and scalability. We adapted Broadbent and Weill (1997)'s characterization of the technical and human aspects of IT infrastructure by differentiating between the technical IT infrastructure, concerning the IT platforms and technologies in the organization, and the human IT infrastructure, concerning the human resources required to manage and provide infrastructure services. The key objectives of the infrastructure architecture standards are to ensure that there is maximum compatibility and minimum duplication and redundancy of both the technical IT infrastructure components and the IT infrastructure services provided by the human resources within the organization. Moreover, given the need to ensure

flexibility and ability to meet the existing and future demands for IT services and capabilities (Byrd and Turner, 2000; Duncan, 2001), we identified the third objective of the IT infrastructure architecture as the need to ensure that the enterprise IT infrastructure is reliable, available, and scalable. We identified the following three key objectives for managing enterprise integration architecture standards: to enable integration of applications across the enterprise, to facilitate ease of communication with external partners, and to manage enterprise data. A summary of the objectives for enterprise architecture is provided in Table 2.

Table 2. Objectives for Effective Management of Enterprise Architecture

OBJECTIVES FOR INFRASTRUCTURE ARCHITECTURE MANAGEMENT
- Reduce redundancy of infrastructure services provided by different IT groups - Reduce heterogeneity of infrastructure components across lines of business - Ensure enterprise system reliability, availability, and scalability
Objectives for Integration Architecture Management
- Enable integration across applications - Facilitate ease of communication with external partners - Management of enterprise data

We define effective management of infrastructure and integration architecture standards as the extent to which organizations are able to achieve the objectives listed in table 2. In the following sections, we describe our hypotheses about the factors influencing the effective management of infrastructure and integration architecture standards.

CENTRALIZATION OF ARCHITECTURE DECISION-MAKING

According to the information-processing theory (Burns and Wholey, 1993), the basic function of the organization's structure is to create the most appropriate configuration of work units as well as the linkages between these units to facilitate the effective collection, processing and distribution of information. A key dimension of subunit structure that affects its information processing capacity is the extent of centralization of a subunit's decision-making authority. Many prior studies have examined the question of how IT departments should be structured (Ein-Dor and Segev, 1982; Olson and Chervany, 1980; Sambamurthy and Zmud, 1999). Three modes of IT governance arrangements include a centralized governance mode, where corporate IS has the authority for IT activities, the decentralized governance mode, where divisional IS and line management assume authority for all IT activities, and different variations of these two extremes for different IT activities (Sambamurthy and Zmud, 1999). Architecture teams can similarly be structured either in a centralized fashion, where IT architects report to the corporate IT department, or they can be structured in a decentralized fashion, where IT architects report to one or more business units. In addition, they can also be structured in a matrix – where they report primarily to the IT division and secondarily to one or more business units (or vice versa).

Researchers who have examined the costs and benefits of the matrix structure compared to a functional or product structure have highlighted the matrix as providing the benefits of proper coordination within a business unit (or project/product development team) while maintaining a continuing linkage with a functional expertise (Ford and Randolph, 1992). A primary advantage of a matrix structure in an architecture team is that it solves an information-processing problem (Davis and Lawrence, 1977). It creates lateral communications channels and improves

communication both within the architecture team and between the architecture team and the IT department as well as the different business units. A related communication benefit of a matrix structure is its ability to handle increased information loads over the more traditional functional structures. The increased contact among departments allows information to "permeate" the organization, improving decision making and response time, which translates into an organization that can quickly and flexibly adapt to a dynamic situation (Davis and Lawrence, 1978; Kolodny, 1979). Improved information flow and flexibility of responses by team members in a matrix can also allow resources to be quickly and easily disengaged from unproductive uses and applied to new opportunities as they are discovered, especially in an uncertain environment. On the other hand, in a matrix, the boundaries of authority and responsibility are split or shared between functional and project managers. This characteristic creates ambiguity and conflict over areas such as resources and technical issues (Ford and Randolph, 1992). Organizations thus have to consider the trade-offs between the coordination cost and the benefits from increased information flow for a matrix structure (Harris and Raviv, 2002).

As infrastructure architecture has more direct impact on IT operations, there is more value in centralizing the infrastructure architecture team with a primary reporting relationship to the CTO/CIO. Given the high coordination costs in a matrix structure (Harris and Raviv, 2002), and the similarity in requirements for infrastructure standards across different business units, there is little value in decentralizing, or creating a secondary relationship with business units for the infrastructure architecture team. Moreover, a centralized structure for architecture decision-making results in easy coordination across all infrastructure architects, and reduces any duplications in infrastructure architecture work across different business units. We thus hypothesize:

H1a: A centralized structure for infrastructure architectural decision-making will enable the organization to be more effective in managing its infrastructure architectural standards.

Integration architecture has greater impact on the work of application developers and business users in different business units than infrastructure architecture. Hence, a centralized structure for integration architecture decision-making may not be an effective approach to managing these architectural standards, as it could result in a tendency for integration architects to come up with architecture decisions without adequate consideration of the impacts to the application developers and business users. Having a matrix organization would bring about greater opportunities for interaction between the architect and stakeholders in business units, while ensuring adequate coordination within the architecture team, and between the architecture team and the CTO/CIO office. We thus hypothesize that a matrix structure where the integration architecture team report to both the CTO/CIO office and to multiple business units is the most appropriate structure for effectively managing integration architecture.

H1b: A matrix structure for integration architectural decision-making where the integration architecture team report to both the CTO/CIO office and to multiple business units, will enable the organization to be more effective in managing its integration architecture standards.

Inter-Unit Coordination and Control Mechanisms

Independent of the organization structure of architecture teams, organizations can put in place processes to ensure adequate involvement of stakeholders who are affected by internal architecture standards. According to the information-processing theory, another key dimension of ensuring information processing capabilities is to make use of coordination and control mechanisms that work to tie interdependent units together. Ensuring adequate coordination and

control between the architecture team and the stakeholders who are affected in one way or other by the architecture standards are very important to bring about adequate use and effectiveness of architecture standards. Having a highly connected communication network will permit efficient use of individuals as problem solvers, since they increase the opportunity for feedback and error correction, and for the synthesis of different points of view (Burns and Wholey, 1993). Hence, we identify different types of inter-unit coordination mechanisms and hypothesize about how the extent of interaction between the architecture team and stakeholders, and the formalization of mechanisms would affect effective management of infrastructure and integration architecture.

The more comprehensive the coordination and control mechanisms are between sub units, the greater the ability of the organization to process information and deal with inter-unit uncertainty (Burns and Wholey, 1993). For architecture standards to be useful to the organization, organizations need to implement procedures to coordinate and control the processes of identifying the scope and requirements for architecture standards, as well as setting, communicating and using the architecture standards. These processes are necessary to ensure that the architects and stakeholders have in place the procedures and routines to help them achieve adequate trade-off between short-term and long-term goals of the organization.

Standards Requirements Identification
Even before setting the architecture standards, enterprise architects have to decide the focus and scope of their enterprise architecture standards. It is very important for the architecture team to obtain the inputs of the right stakeholders at this stage where they are identifying the requirements of the organization's architecture standards. If the stakeholders have a say in which types of architecture standards they think are the most important and that the organization should focus their resources on, they will be better able to recognize the need for the architecture standards. They also will be more willing to participate in the standards management process in the later stages (Ives and Olson, 1984).

> **H2a:** Organizations who ensure that the necessary stakeholders are involved in defining the scope and requirements of enterprise architecture are more effective in managing their enterprise architecture.

Standards Setting
In setting architecture standards, architects should set standards with good feedback and awareness of the current conditions and constraints facing the organization. The views and perspectives of business and IT groups should be factored into the standards setting process. In changing architecture standards, organizations also need to put in place adequate feedback loops to ensure that architecture standards are kept up to date and remain flexible to changing business conditions. We thus hypothesize:

> **H2b:** Organizations who have in place defined processes to ensure adequate stakeholder representation in the standards setting and standards changing process are more effective in managing architecture standards.

Standards Communication
In order for architecture standards to be widely used and adopted within the organization, there should be adequate communication of both the standards and the value of the standards to the stakeholders who are affected by the architecture standards. These include mechanisms and processes to ensure that the architecture standards are available to all that should have access to it and changes to the architecture standards are distributed in a timely fashion. Also included

are activities that ensure business and IT users understand the importance of adhering to the architecture and how it impacts their daily business activities. We thus hypothesize:

H2c: Organizations who have in place defined processes to ensure adequate stakeholder representation in the standards communication process are more effective in managing architecture standards.

Standards Conformance

To ensure that architecture standards are effective in governing IT management within the organization, organizations need to have in place mechanisms to ensure adequate conformance to architecture standards. This would include mechanisms and processes to review and approve decisions that should be made in accordance with the architecture, such as formal design and product reviews. There should also be designated means to ensure that exception to standards can be granted where necessary. Such exception mechanisms would include mechanisms and processes to provide a means of appealing architectural decisions and allowing exceptions to the architecture that permit the use of nonconforming technology to meet unique business requirements. We thus hypothesize:

H2d: Organizations who have in place defined processes to ensure adequate conformance to architecture standards and designated means to consider exceptions to standards conformance are more effective in managing architecture standards.

Scope of Influence

It is not only important that organizations have the necessary inter-unit coordination and control processes in place, but it is also important that the scope of the influence of these processes be wide enough to involve the necessary stakeholders. For example, the scope of influence of infrastructural architecture is different than that of integration architecture. While the former would generally include the IT operations, development personnel, and application owners, the latter would additionally include business representation, such as line management, IT business analysts, and perhaps even business strategy. The IT business analysts would be responsible for collecting architecture standards requirements and feedback from the business units and communicating them to the architecture team. We thus hypothesize:

H2e: For the inter-unit coordination and control mechanisms to be effective, the scope of influence for infrastructural architecture decisions need to involve IT development, operations personnel, and application owners. The scope of influence for integration architectural decisions need to additionally involve business personnel, such as line management, business strategy, or IT business analysts.

Participation of Architects in Projects Making Use of Architecture Standards

To be able to set effective architecture standards, architects not only need to have good knowledge of IT architecture, but they also need to have adequate knowledge about the domain that their architectural standards will affect. Common experience reduces communication barriers and provides common referents (Walton and Dutton, 1969). Architecture teams who do not know about the problems and difficulties in implementing the architecture standards may have a tendency to become too theoretical in applying architectural principles, and they may not know what types of enterprise architecture are effective and how they are to be actually implemented. This lack of knowledge can even lead to unreasonable inter-unit demands through ignorance. Hence, it is important for the architecture team to have hands-on experience working with or working on projects that make use of the architecture standards that the team sets, as it will help the architects identify the problems faced by users of the architecture

standards. This is thus a key mechanism to: (1) provide a feedback mechanisms so that the architecture team can gain experience in making use of the standards that they set and (2) improve the communication between the architecture team and the stakeholders making use of the architecture standards. We thus hypothesize:

H3: IS Architecture teams that ensure their architects participate in projects that make use of the architecture standards they set are more effective in managing their enterprise architecture.

Control and Mediating Variables

For a more complete research model, it is also important to include other control variables that are expected to affect the ability of the organization to effectively manage their architecture standards. We include organizational level control variables such as organization size, industry, and the extent of IT centralization. We also include variables that measure various aspects of the architecture team that would be important contextual information to consider. These include the extent of top management support for architecture work within the organization, the number of years that different architecture groups have been formed, the level of the lead architect of different architecture groups in the organizational hierarchy, and the types of performance metrics used to evaluate the performance of architecture teams. We also take into consideration the fact that different organizations will place different emphasis and priorities on different architectural objectives, and include, for each architectural objective, a control variable indicating priority that the organization places on each architecture objective.

In addition, we identified two mediating variables that mediate all the independent variables, and the extent to which each organization is able to effectively achieve each of the architecture objectives. These variables provide an indication of the intermediate success of the work done by the architecture team: (1) whether the organization has defined formal architecture guidelines and internal standards to ensure that each architectural objective is achieved, and (2) the extent to which members of the company use and conform to the formal company-defined architectural guidelines and internal standards. On one hand, these are dependent variables that are affected by the independent variables in our hypotheses and control variables, but they are also independent variables that will influence the extent to which the organization can achieve its architectural objectives. We thus hypothesize:

H4a: The extent to which the organization has defined formal architecture guidelines and internal standards to ensure that each architectural objective is achieved mediates the relationship between the independent variables and the extent to which the organization can achieve each architectural objective.

H4b: The extent to which members of the company use and conform to the formal company-defined architectural guidelines and internal standards mediates the relationship between the independent variables and the extent to which the organization can achieve each architectural objective.

METHODS

To test our hypotheses, we plan to use a sequential mixed methods design (Tashakkori and Teddlie, 1998). First, we use a qualitative case-study method to conduct interviews at several organizations to examine how they manage their architecture standards. Subsequently, we plan to use a quantitative survey method to survey organizations to systematically obtain measures of our variables and test our hypotheses.

We have conducted case studies in four organizations so far. For the case studies, we conducted interviews with lead architects and executives overseeing the IT function. These case studies serve as a reality check for our hypotheses and also provide information about the context of various organizations, and helped us to determine how we should operationalize our constructs for the survey. To illustrate the findings from the case study, the following section describes two of the case studies and explains how they relate to our hypotheses.

CASE STUDIES

Case #1: Insurance Organization (IO)

Insurance Organization is an insurance and financial services organization that offers auto insurance, as well as homeowners, health, and life insurance. IO has a highly centralized structure for organizing their IT operations, where all lines of business are supported by the Corporate IT team. Even business analysts who are writing business requirements for applications are also considered to be under the Corporate IT team. This was partly a result of the heritage of IO, as the organization had traditionally been growing from within, and had few mergers and acquisitions. IO has focused on developing their infrastructure architecture standards in the past few years, and has only begun to work on developing their integration architecture standards.

IO has been quite effective in ensuring compliance to their architecture standards, as 99% of the organization's projects are compliant with their infrastructure standards. This has largely been facilitated by their centralized IT and architecture organization structure, such that they can easily institute controls and processes to ensure that all IT operations conform to the standards, and to ensure that they obtain the input of fellow colleagues in the IT group when defining the infrastructure standards. The fact that they are the only IT organization with the necessary expertise to provide the support to IT products also help to ensure they have centralized control of all IT work and projects.

IO has recognized the importance for integration architecture to be closely aligned with business goals and the need to obtain much greater business involvement in developing and managing the integration architecture. An initiative, started by one of their Vice Presidents from line management, was the establishment of an "integration office" that is independent of all business areas to generate an architecture of the business process flows. They have involved representatives from various lines of business and from IT to help in this initiative. The establishment of a business architecture will create strong fundamentals for the integration architecture to build upon. While IO has yet to put in place the governance processes for their integration architecture, they were able to point to some pockets of success within the organization. For example, they had a project to build a database that has a consolidated view of customers, integrating customer data from each major line of business. It took them many years, but at this point, they now have consolidated view of customers that is considered an "authoritative source of information", and a consolidated store of customer relationships that different projects use. This project was championed by the business side of the organization.

The experience of IO provides preliminary support for our basic premise that management of integration architecture requires greater business involvement and consideration of business goals (H1a). Their experience also highlights the importance of a centralized architectural organization structure for the management of infrastructure architecture (H2a) and inter-unit coordination and control processes (H3) for effective architecture standards management.

Case #2: Investment Firm

The Investment Firm (IF) is an investment and brokerage firm that focuses on providing brokerage and investment services to individual investors. IF has a semi-centralized structure for organizing the IT operations, where they have a corporate IT team (Corporate IT), which has an internal structure aligned with the different lines of businesses. IF also has IT personnel who report directly to line management and are independent of the corporate IT team. Within Corporate IT, they have defined roles for architects, and the architects are divided into two teams, in charge of the infrastructure and integration (including application and data) architecture respectively. IF has been moderately successful with setting up their enterprise infrastructure architecture, but has been having problems in setting up the enterprise integration architecture.

IF has institutionalized several processes to ensure adequate review, communication, and compliance to the architecture standards. All projects have to be reviewed by a designated group in Corporate IT to ensure that the projects follow architecture standards. If projects are seeking exemptions from having to adhere to current standards, mechanisms exist for projects to be escalated up to higher management. Communication channels and venues also exist to ensure standards are adequately communicated to and reviewed by all IT staff. While these processes have helped them to effectively manage buy-in and compliance from the IT personnel in Corporate IT, the scope of influence for these processes was not broad enough to include all business-initiated IT projects outside the purview of the IT organization. As a result, purchase and project decisions made in the lines of business were sometimes not aligned with the architecture standards set by IF. To circumvent this problem, the architecture team assigned the role of “gatekeepers” to the contracts department to ensure that any IT purchases made by the various lines of businesses cannot be approved unless they have gone through the project review process in Corporate IT.

IF’s attempts at setting up an enterprise integration architecture have been less successful, mainly due to the lack of involvement of IT development and operations personnel and line management. For example, IF attempted to generate a data model for their business and assigned this task to a data modeling team. The team did not ensure the participation of the stakeholders and was not sufficiently aware of the actual practice of how things worked. As a result, the project based upon the data model failed due to performance issues and the modeling team was ultimately dissolved. Two years earlier, the organization recognized the need better business alignment with the integration architecture. To effect this, they separated the integration architecture team from the infrastructure team, and distributed the integration team across various lines of business. The centralized structure of the infrastructure team worked out relatively well, but due to the decentralized structure of the integration architecture team and the lack of coordination with the infrastructure team, there was a tendency for the integration team to cross into infrastructure issues (their earlier comfort zone), instead of sticking to clearly defined integration issues.

The experience of IF provides preliminary support for our basic premise that management of integration architecture require greater business and IT personnel involvement. Our hypotheses about the need for a centralized structure for the infrastructure architecture (H2a), a matrix structure for the integration architecture (H2b), and adequate scope of governance processes (H3) for effective architecture standards management also found some initial support.

CONTRIBUTIONS AND FUTURE RESEARCH

These case studies provide some preliminary support for our hypotheses. We are currently conducting the second part of the mixed-method study – collecting data for the survey. We expect that this research will be able to contribute to the research in ICT standards development by providing an intra-firm perspective to standards development. Most standards research focus on standardization of ICT standards across an industry. Prior research has not focused on standards management issues within organizations. Given that the ultimate aim of industry standards is organization adoption, we think that it is important for researchers to examine the issues surrounding the management of ICT standards within the organization, which gets manifested as architectural standards.

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