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FRAMEWORK FOR MEASURING E-BUSINESS ARCHITECTURE FLEXIBILITY

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Abstract

In the fast paced environment of e-business, the ability to adapt to change is a competitive advantage. In this environment, architectural flexibility – the ability to adjust the technology-business structure with minimal penalty – is a strategic resource. We use Structuration Theory as a lens to view e-business architecture and develop a framework to measure its flexibility. By measuring e-business architecture flexibility, we are capturing a key independent variable that is a contributor and antecedent to e-business success.

Keywords: E-business architecture, flexibility, structuration theory, strategic advantage

Introduction

Many studies have demonstrated that IT can provide unprecedented opportunities for the redistribution of knowledge, resources, and conventions in organizations (Barua et al. 1996; Mata et al. 1995). The emergence of the Internet and e-business is an example of such redistribution (Markus 2000). The most important decision for non-stop e-business is how to build an architecture (Silwa 1999). Whether e-business is one strategy within a brick and mortar organization, or is the foundation of a firm, the information technology (IT) architecture that supports e-business is critical to achieving strategic and competitive goals.

E-business poses inter-organizational challenges that demand flexible solutions to frequently changing requirements (Barua et al. 1996; Kalakota and Robinson 1999). Incompatibility of systems and architectures can prevent organizations from executing e-business strategies and forming e-business partnerships (King 1999). Lack of appropriate or compatible IT infrastructure has proven to be a major obstacle for organizations attempting to join electronic marketplaces (Nash 2000). E-business shifts knowledge and resources from the organizational level to the inter-organizational level, and fundamentally changes how organizations compete and succeed (Barua et al. 1996). The flexibility of the e-business architecture will be a key determinant of whether an e-business strategy is viable or successful.

This paper contributes to the e-business metrics literature in several ways. First, we consolidate the many, often contradictory, definitions of IT architecture and e-business architecture (Agosta 1999; Byrd and Turner 2000; Crowcroft 1995; Kachur 2000; Raghunathan and Madey 1999). Second, we use Structuration Theory (Orlikowski and Robey 1991) as a lens to view e-business architecture and develop a framework for measuring e-business architecture flexibility. Third, we find support for this framework in the existing information system literature, extending the theory of flexibility metrics (Byrd and Turner 2000; Duncan 1995; Nelson and Ghods 1998).

Definitions

Architecture

“Architecture” is used in a variety of contexts to mean either a high-level abstraction or an explicit implementation plan/outline. For example, Agosta (1999) defines architecture abstractly as a collection of first principles of coordinating commitments. Whereas Kachur (2000) defines architecture concretely as an integrated working system made up of functional layers. It is important to distinguish between the concepts of IT frameworks, IT infrastructure, and IT architecture. An architecture is a

conceptual way of managing technology and aligning it with business (Crowcroft 1995). A framework specifies the standards and protocols needed to implement the architecture. An infrastructure is the implementation of the framework.

Architectures pass attributes to frameworks and infrastructures. For example, Byrd and Turner (2000) view IT infrastructure as having two components: technical and human. Similarly, Raghunathan and Madey (1999) propose a framework of IT infrastructure for e-business that tightly couples technical and human factors. We abstract these concepts and define IT architecture as:

A coherent system of technical principles that guide the management of information systems towards the objectives imposed by business managers.

To arrive at a definition of e-business architecture, we must account for the complexities of e-businesses. First, the e-business principles guide not only management, but also all the stakeholders in the extended organization. In this environment, the need to synchronize business models, processes, and representation formats rises rapidly (Kumar and van Dissel 1996). Second, expectations on the Web are stricter (Joachim 2000). We define e-business architecture as:

A coherent system of management and technical principles that guide the management of the extended organization towards the optimal alignment of IT and business strategy.

Flexibility

Nelson and Ghods (1998) define technology flexibility as the ability to adapt to both incremental and revolutionary changes with minimal penalty. E-business architectures are fundamentally more complex than individual IT systems. For example, a critical challenge is identifying the reusable and modifiable portions of an existing business architecture and combining these with newer-generation e-business technologies (Yang and Papazoglou 2000). E-business architecture flexibility is defined as:

The ability to adapt the architectural implementation (components and structure) to changes in the value chain, in a manner that supports the internal needs of the business and the compatibility needs of the e-business partner, with minimal penalty.

Methodology

In general, IS characteristics (flexibility for example) are measured indirectly. Structuration Theory (Orlikowski and Robey 1991) suggests a means for building determinants. We define a determinant as a measurable property that provides an indication of the degree to which the given characteristic has been achieved (Jones 1993). Structuration Theory (DeSanctis and Poole 1994; Orlikowski 1992; Orlikowski and Robey 1991) has been frequently used in IT research (Boczkowski 1999; Brooks 1997; Hackney and Little 1999; Lee and Grover 2000; Markus 1994) since it captures the complexity of interactions between people, processes, and technology. Nagasundaram and Bostrom (1994) showed that individuals adapt structures from processes and technologies. In adapting these to their needs, they either confirm or change the organizational structures of meaning, domination, and legitimacy.

We use the Structuration Theory as a lens to view e-business architecture flexibility and to build the appropriate determinants for the construct of e-business architectural flexibility. Through this lens, e-business architecture flexibility is seen as a three-dimensional construct with three determinants in each dimension corresponding to the three modalities (Table 1). People, technology, and processes are dimensions that define the organization. The modalities are the types of interactions between these dimensions, as described by Structuration Theory. As we view these interactions through the lens of a given modality, we can develop an appropriate determinant of e-business architecture flexibility. The determinants in Table 1 are further supported in the IT flexibility literature (Byrd and Turner 2000; Duncan 1995; Nelson and Ghods 1998).

Table 1. E-business Architecture Flexibility Determinants

E-Business Architecture Flexibility	People	Technology	Process
Interpretive Schemes	Expertise	Consistency	Embedded process knowledge
Resources	Coordination	Modularity	Methodology
Norms	Responsiveness	Change acceptance	Adherence to standards

Structuration Theory

Interpretive Schemes

Interpretive schemes are standardized shared stocks of knowledge that humans draw on to interpret behavior and events. They enable shared meanings, mediate communication, and serve as conduits for the imposition of structural constraints. They comprise social rules called “structures of signification.” These structures enable, inform, and inhibit the communication process (Orlikowski and Robey 1991). For example, CASE tools contribute to structures of signification because the concepts and procedures embedded in them communicate the manner in which problems are interpreted and solved (Orlikowski 1992). In the people dimension, an appropriate interpretive-determinant of flexibility is one that measures “communication of meaning” affecting agile response. In the technology dimension, an appropriate interpretive-determinant is one that measures the degree to which information technology is a product and a medium of such communication. And, in the process dimension, an appropriate interpretive-determinant is one that measures the degree to which there are processes that enable, inform, and inhibit communication critical to e-business flexibility.

Interpretive-determinant of flexibility in the people dimension

Expertise is the critical knowledge required in the strategic role of an e-business architecture. The flexibility depends on the degree to which it exists and is positively communicated (Byrd and Turner 2000; Nelson and Ghods 1998). Skills (the experience and expertise) of personnel are the least tangible and most difficult resources to analyze, yet they may constrain the quality of the other resources (Duncan 1995). E-business architecture *expertise* is defined as:

The degree that both sufficient and necessary knowledge exists and is positively communicated among the various e-business stakeholders.

Interpretive-determinant of flexibility in the structural dimension

In a flexible e-business architecture, technology should serve as a reliable medium for communicating expertise. We call this attribute consistency. Technology with this attribute is both a product and produces structures of significance necessary for flexibility. Byrd and Turner (2000) require data transparency; the free retrieval and flow of data regardless of location. Nelson and Ghods (1998) have a more comprehensive definition of consistency, which does not limit the notion of consistency to just data. Similarly, Duncan (1995) showed that the share-ability of all IT resources through consistency is fundamental to flexibility. E-business architectural *consistency* is defined as:

The degree that data, functionality, and components are integrated consistently across the extended organization's IT infrastructure.

Interpretive-determinant of flexibility in the process dimension

Organizational knowledge emerges as plans, experiences, language, habits, models, practices, tools, and processes within the organization (Giddens 1984). When knowledge is embedded, it requires that people understand how the originator of the knowledge fixed the meaning (Tuomi 1999). These processes and mechanisms constitute the structures of signification that affect flexibility. *Embedded process knowledge* is defined as:

The degree to which there are processes and mechanisms that help promote knowledge transfer and capture knowledge independent of the experts that generated it.

Resource

“Resources are the means through which intentions are realized, goals are accomplished, and power is exercised.” (Orlikowski and Robey 1991, p. 148). They mediate the use of power of human action to transform the social and material world. They are structural elements that constitute organizational structures of domination (Orlikowski and Robey 1991).

In the people dimension, an appropriate resource-determinant is one that measures “human action” that provides an indication of e-business architecture flexibility. The key human action needed to make such adaptations is people’s ability to synchronously perceive and respond to opportunities and threats (Duncan 1995; Nelson and Ghods 1998). In the technology dimension, an appropriate resource-determinant is one that measures the degree to which information technology is a product and a medium of such human action. And, in the process dimension, an appropriate resource-determinant is one that measures the degree to which there are processes that enable, inform, and inhibit such human action.

Resource-determinant of flexibility in the people dimension

An understanding of each other's perception and those of the extended organization enables the coordination needed to communicate opportune perceptions and consistently manage projects (Nelson and Ghods 1998). Many of the problems underlying failed IT investments can be linked to lack of coordination (O'Brien 2000). Even at the technical level, barriers to flexibility arise when changes to the technology are not agreed upon or mutually understood (Nelson and Coopriider 1996). E-business architectural *coordination* is defined as

The degree to which the groups needed to carry out strategic adaptations understand each other's requirements and those of the extended e-business organization.

Resource-determinant of flexibility in the technology dimension

The degree to which such formal separation exists at the level of architectural principles determines the extent to which the principles can exert their influence unencumbered by each other. For example, modularity enables scalability (Cahoon et al 2000) and reuse (Duncan 1995). As components become independent and reusable, they become part of the infrastructure, and the processes of development, maintenance, and reengineering are simplified (Duncan 1995). Loosely coupled modular systems can accommodate change as well as foster self-determination, experimentation, and innovation (Orton and Weick 1990). E-business architectural *modularity* is defined as:

The degree of formal design separation within the e-business architecture (Nelson and Ghods 1998).

Resource-determinant of flexibility in the process dimension

Business processes, procedures and policies, should enable coordination (Nelson and Ghods 1998). As organizational structures of domination, processes enable and inhibit the flexibility needed to pursue a strategic opportunity or avoid a strategic threat. For example, DeSanctis and Jackson (1994) found that whereas decentralization may bring flexibility, some degree of centralized planning is needed to enable systems integration, standardization, and economies of scale. E-business architecture *methodology* is defined as:

The degree to which the extended organization creates a shared strategic vision and has in place procedures and policies that promote and support that vision.

Norms

"Norms are the rules governing sanctioned or appropriate conduct, and they define the legitimacy of interaction within a setting's moral order" (Orlikowski and Robey 1991, p. 148). They play an active role in the shaping of and are guided by institutional notions of legitimate behavior. Lee and Grover (1999) point out, for example, that actions facilitated by technology may, over time, institute a new way of doing things and a new sensibility about which technologies are appropriate. Such changes yield social outcomes that might recursively affect the very technologies that generated those social outcomes (Boczkowski 1999). In the people dimension, an appropriate normative-determinant is one that measures the extent of norm-influenced actions evincing e-business architecture flexibility. In the technology dimension, an appropriate normative-determinant is one that measures the degree to which information technology is a product and a medium of such norm-influenced actions. And, in the process dimension, an appropriate normative-determinant is one that measures the degree to which there are processes that enable, inform, and inhibit such actions.

Normative-determinant in the people dimension

Flexibility requires the ability to change quickly from one set of tasks to another (Duncan 1995). Even if people possess the knowledge to capture an opportunity and possess the capacity to coordinate a response, the window of opportunity will be lost if the transition time (Nelson and Ghods 1998) is too long. Yet, what constitutes timeliness is a cultural notion. Being timely connotes moral sanction. E-business architecture *responsiveness* (Nelson and Ghods 1998) is defined as:

The timeliness in making changes to the e-business architecture in response to a strategic e-business need.

Normative-determinant in the technology dimension

Change of acceptance, the built-in capacity for change, is an indicator of technology flexibility (Nelson and Ghods 1998). Platform readiness for new software, easy access to relevant data, and the presence of necessary networking systems all affect flexibility (Duncan 1995). Scalable technologies (Fayad et al. 2000), middleware (Freeman 2000), open systems (MacCormack and Herman 2000) are examples of architectural built-in capacity for change. As such they support responsiveness and condone

innovation and experimentation, norm-based actions critical to e-business flexibility. E-business architecture *change acceptance* is defined as:

The degree to which an e-business architecture contains built-in capacity for change.

Normative-determinant in the process dimension

Methodology provides the resources and guidelines needed for continuous strategic change. But methodology is worthless without the moral imperative demanding its effective use. The institutionalized norms in a system development methodology, for example, can influence the development of productivity tools (Orlikowski 1992). As a normative influence, standards enable embedded process knowledge. Not adhering to standards can lead to the deterioration of methods, the loss of key knowledge, and cause an e-business to fail. E-business architecture *adherence to standards* is defined as:

The degree to which individuals in the extended organization recognize and comply with standards instituted to enable strategic change.

Discussion and Future Research

Structuration Theory is an appropriate way to measure e-business architecture flexibility because it integrates the complex interactions between people, technology, and processes. Through this lens, e-business architecture flexibility is seen as a three-dimensional construct, aligned to the e-business strategy of the organization. Architectural flexibility is therefore no longer a purely technical issue; it is a key element of the organization's overall e-business strategy.

Our framework will be tested in four ways. The first method will be discovery interviews with practicing technical and business architects to understand the flexibility needs of an e-business architecture. The second method will view the findings of the practitioner interviews through the lens of Structuration Theory to distinguish the unique needs of an e-business architecture and how and why it needs to be flexible.

Once the e-business architecture flexibility determinants developed in this paper have been adapted through the first two steps, a Delphi study (Sackman 1974) will be performed with practitioners to pilot test the importance and accuracy of these flexibility metrics. Finally, a field study survey will be performed and analyzed using structural equation modeling to validate the constructs of e-business architectural flexibility proposed in this framework.

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