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IS/IT Architecture: An Integrated View and Typology

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ABSTRACT

Information system (IS/IT) alignment has been an important issue facing managers for many years. One important aspect of the alignment problem is that the IS/IT function must meet the often conflicting corporate and business unit demands. Although IS/IT architecture has been widely recognized as an important organizational mechanism for optimally coordinating these demands, there are no consistent conceptualizations about what constitutes IS/IT architecture. In addition, there are no integrative frameworks that help understand the key types, dimensions and organizational design considerations of IS/IT architecture. In this paper, based on the need to meet corporate and business units demands, we conceptualize a typology of IS/IT architecture. Drawing from the literature, we conceptualize the key dimensions and characteristics of IS/IT architecture. We then propose an integrated framework that describes the organizational design considerations based on the typology and dimensions of IS/IT architecture. The paper contributes to the research literature by providing an integrative view of the concept, typology, dimension and organizational design considerations of IS/IT architecture.

Keywords

IS/IT Architecture, Relational Architecture, Integrating Architecture, Standardization, Organizational Structure, Alignment.

INTRODUCTION

The results of a recent survey of more than 80 chief information officers (CIOs) from Fortune 1000 companies reveals that information systems/information technology (IS/IT) alignment is the most significant managerial issue faced by top IS/IT executives (Xia and Adams, 2003). IS/IT alignment has consistently been among the top IS/IT managerial challenges for many years (Hogue, 2002). Alignment is, and has persisted as, an important issue because, although managers almost universally acknowledge the importance of alignment; it is difficult for most to achieve within their organizations (Chan, 2002).

Our interactions with CIOs from large us firms have confirmed the importance of alignment and provided insight into the complexity inherent in improving alignment. IS/IT must meet a complex – and often competing – set of objectives (Brown and Magill, 1998; Ross, 2003) from both corporate and business units. Together, these objectives create a complex set of demands upon the IS/IT function.

IS/IT must be designed at the functional level to meet this complex set of demands. Sambamurthy and Zmud (2000) identify two types of architecture that must be considered as part of the organizational design for IS/IT: relational and integrating architectures. There are rich bodies of research which examine the constructs related to integrating and relational architectures in isolation. Very little research has presented a comprehensive view of IS/IT architecture or described the relationships among integrating and relational elements of the overall design for IS/IT activities.

We examine IS/IT architecture by addressing the following research question: how does considering the complex set of organizational objectives that must be met by IS/IT improve our understanding of the IS/IT architecture concept? In response

to this question, we have developed a typology of IS/IT architectures based on the organizational demands that are placed on IS/IT and a comprehensive view of the dimensions which comprise the IS/IT architecture construct.

Organizational Demands on IS/IT

Figure 1 illustrates a framework for clarifying the nature of the demands that corporate and business units place on IS/IT. Corporate objectives for IS/IT are normally concerned with creating IS/IT synergies across the organization. Demands for synergy may result from corporate desires ranging from minimizing IS/IT costs to improving corporate competitiveness through the integration of organizational systems. On the other hand, business unit demands on IS/IT are for various IS/IT capabilities that are important to the competitive plans of the different business units.

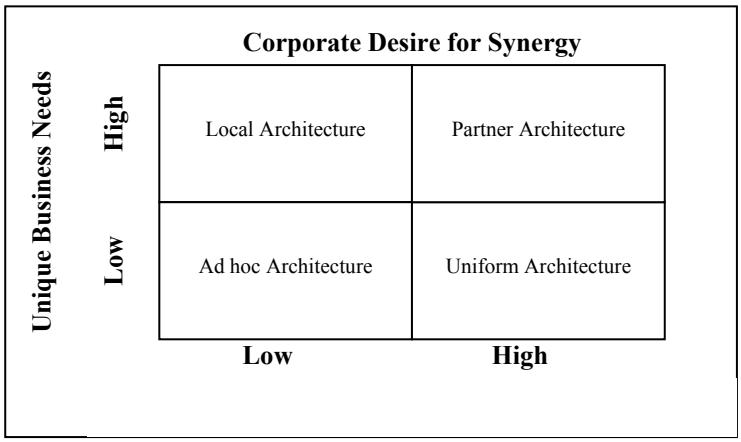

Figure 1. IS/IT Architectures Based on Organizational Demands

By examining these demands simultaneously, we have developed a classification of the demands that are placed on IS/IT. When organizational demands for IS/IT synergy are low, but there is high demand to service a large number of unique business needs; the needs of business units becomes the compelling force that defines the IS/IT architecture. When organizational demands for IS/IT synergy are high, but there is a low demand to service unique business unit needs; the demand for synergy becomes the driving factor in the design of IS/IT. When there are both strong demands for synergy and IS/IT must support a large number of unique business unit needs, then both the demand for synergy and the demand to service the needs of business units shape the IS/IT architecture. Finally, when the demand for synergy is low and IS/IT must service a relatively small set of unique business unit needs, then there is no compelling force within the organization that defines IS/IT architecture. Often in such organizations, IS/IT is not viewed as a strategic asset and IS/IT architecture is therefore managed on an ad hoc basis.

In the next section, we will discuss the two main types of IS/IT architecture: relational and integrating architecture. Integrating architecture consists of two components: technical and organizational.

RELATIONAL ARCHITECTURE

IS/IT Relational architectures describe the relationships among the various entities that provide resources to organizations in the creation and delivery of IS/IT capabilities (Choudhury and Xia, 1999; Sambamurthy and Zmud, 2000). Teece, Pisano, and Shuen (1997) argue that organizational capabilities are a function of tangible and intangible assets, processes and path. Networks of relationships are key intangible assets that may be utilized in the delivery of IS/IT capabilities and thus are important for understanding the nature of the capabilities that IS/IT provides.

Choudhury and Xia (1999) describe the nature of relational architectures. Relational architectures may be fully internal, fully external, or inter-organizational. From the perspective of IS/IT, a fully internal architecture consists of entities that are controlled directly by the corporate IS/IT function, a fully external architecture consists of entities that are not controlled by the IS/IT function, and an inter-organizational architecture is comprised of some entities that are controlled by corporate IS/IT and some that are not.

Relational architectures can also be described in terms of dynamism. An architecture is considered stable if the entities utilized in the delivery of a particular IS/IT capability are used every time the capability is delivered. An example of a stable architecture is one where the same systems development group within an organization is repeatedly called upon to deliver all

of the systems development efforts of the organization. An architecture would be considered dynamic if different entities were utilized in the repeated delivery of an IS/IT capability.

The transaction cost economics (TCE) literature (Coase, 1937; Williamson, 1975) provides insight into the choices managers make concerning relational architectures. Under the TCE perspective, the existence of firms can be explained by understanding the transactions that are necessary in the delivery of a product or service. A transaction will take place within the institutional framework under which it can be done most efficiently (Balakrishnan and Wernerfelt, 1986). In other words, a product or service will be delivered within an organization if it is more efficient to do so, but acquired in a market when that is the most efficient mechanism. Organizations also utilize governance structures that fall between these two extremes. Such governance structures are not completely characteristic of either markets or firms (Gulati, 1995; Ring and Van de Ven, 1992).

Markets and market-like governance structures are utilized when there is a high degree of uncertainty as well as a low degree of asset specificity and of frequency associated with an exchange (Jones, et al, 1997). Dyer and Singh (1998) argue that markets and market-like structures are also characterized by minimal exchanges of information between partners, low levels of organizational interdependence, and minimal investment in governance mechanisms.

IS/IT relational architectures must fit organization demands for IS/IT. Two factors, asset specificity and interdependence, influence the nature of the transaction costs associated with delivering IS/IT capabilities. Asset specificity relates to the degree to which organizational specifications must exist for IS/IT to deliver special capabilities to the organization. Organizational specifications create IS/IT synergies. As asset specificity increases, so does the likelihood that an internal or inter-organizational architecture will be utilized in the delivery of the capability. Therefore we expect internal and inter-organizational architecture to be utilized when there is a high demand for IS/IT synergy.

Interdependence refers to the extent to which the business units within the organization utilize common IS/IT capabilities and is thus inversely related to the number of unique business needs that IS/IT must support. Interdependence and dynamism are related. As interdependence increases so does the likelihood that an entity will be involved in the repeated delivery of the IS/IT capability to ensure consistency and limit the costs associated with delivering that capability. Therefore, as interdependence increases, so does architecture stability.

The fully external/dynamic structure is most appropriate under conditions of low asset specificity and interdependence. This architecture is therefore most appropriate when organizational demands for synergy are low and IS/IT must support a large number of unique business unit needs.

Inter-organizational/dynamic structures are most appropriate when asset specificity increases and interdependence remains low. Thus inter-organizational/dynamic architectures are most appropriate when the demand for synergy and to service a large number of unique business unit needs are both low. Although there is little demand to service unique business needs, IS/IT capabilities are not shared across business units under such demands. Asset specificity increases as a result of organizational efforts to reduce IS/IT costs by limiting the number and types of technologies utilized within the organization.

When organizational demand for synergy and to service a large number of business unit needs is high, we expect to see high levels of asset specificity and low levels of interdependence. Under such circumstances, we would expect to see organizations using inter-organizational/stable relational architectures.

When demand for synergy is high and IS/IT does not endeavor to service many unique business unit needs, we expect to see high levels of asset specificity and high levels of interdependence. This would imply that fully internal and stable architectures are most appropriate. In summary, relational architecture is influenced by organizational demand for IS/IT. Next we describe integrating architectures and how they are related to organizational demand for IS/IT.

INTEGRATING ARCHITECTURES

Allen and Boynton's (1991) definition of architecture – the set of policies and rules that govern an organization's actual and planned arrangements for computers, data, human resources, communications facilities, software, and management responsibilities - captures our notion of integrating architecture. Integrating architecture is comprised of technical and organizational components. Technical architecture describes organizational arrangements for computers, data, communications facilities, and software; while organizational architecture highlights the arrangements for human resources and management responsibilities. Both types of integrating architecture (technical and organizational) serve to coordinate IS/IT activities and outcomes within the organization including the development and use of various relational architectures.

Technical Architecture

IS/IT standards are particularly relevant in a discussion of technical architecture (Ross, 2003). Mintzberg (1979) highlights five mechanisms managers use to coordinate organizational activities. Three of which are relevant to a discussion of technical architecture: standardization of inputs, standardization of outputs, and standardization of processes.

Inputs include all of the technical elements of an information system that are brought together in creating the system, including hardware and software platforms. Outputs include functionalities provided by these systems, including applications and data. Processes include all of the IS/IT organizational routines related to the planning, development, operations, and support of information systems. In many cases, the development of output standards implies that the standardization of inputs exists to help create the output standards. In like manner, the standardization of processes typically implies the standardization of outputs. This creates a hierarchy of standards where a firm may choose to employ only input standards; input and output standards; or input, process, and output standards.

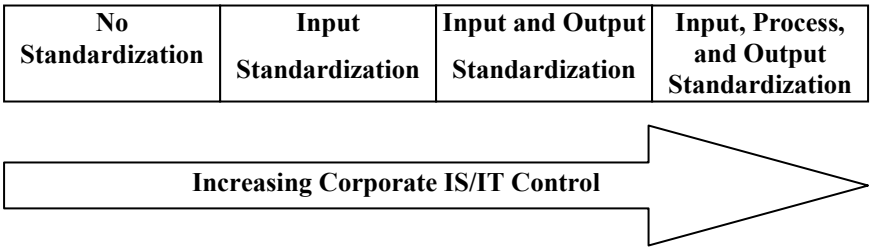

Figure 2. Levels of Standardization and Control

Consistent with Mintzberg, we recognize that the amount of control that can be exercised by the corporate IS/IT function through standardization depends on the type of standardization utilized. It is possible to map the different types of standardization on a continuum of control (see Figure 2). At one extreme, managers choose to not set up technical standards and the corporate IS/IT function does not exercise any control. The most control is exercised by the corporate IS/IT function when inputs, outputs, and IS/IT processes are all standardized. Between these extremes, managers choose to standardize either only inputs or both inputs and outputs.

The strategic management literature on corporate diversification provides insight into the choices managers make concerning technical architectures. The control mechanisms that must be put in place to incorporate business units within an organization create bureaucratic costs (Jones and Hill, 1988) which must be outweighed by the value created by the multi-business operation. By analogy, employing IS/IT standards are costly for organizations. The costs of standards are greatest when IS/IT must support a large number of unique business unit needs, because the task of creating standards becomes more complex as the number of different systems increases and managers of individual business units have greater incentives to deviate from standards to service a local strategic need.

These costs must be outweighed by potential synergies, or economies, created by the standardization before the IS/IT standards are justified. Jones and Hill (1988) discuss the economies that diversified firms achieve from each of the diversification strategies (integration, related diversification, and unrelated diversification): economies of integration, economies of scope, and economies of internal markets. Economies of integration result from the ability to utilize specialized assets to increase organizational efficiency, eliminate sub-optimization in the allocation of organizational resources, and reduce the need to draft complex contracts to control behavior. Economies of scope arise through the sharing of strategic resources across business unit boundaries. Resources may be imperfectly divisible, meaning that the purchase of a resource may lead to costly excess capacity for a fully autonomous business. The sharing of such resources across business units allows for the capacity of a resource to be fully utilized. Economies of scope may also result from the creation of organizational synergies across common business units. Economies of internal markets include the ability to allocate resources, monitor business unit performance, and remove the leadership of a poorly performing business unit more efficiently than a market.

By analogy, one can describe three types of economies that are created within the information systems function: economies of scale, economies of scope, and economies of integration. Economies of scale are derived from the ability to reduce costs in acquiring and maintaining IS/IT resources. This is done by standardizing IS/IT input thereby limiting the technologies that are supported within the organization. Economies of scope are derived from the sharing of IS/IT resources across business units and the creation of IS/IT related synergies across business units. This is accomplished by standardizing the IS/IT

outputs of the organization. Economies of integration in the context of information systems stems from the ability to maintain specialized assets to improve the efficiency of IS/IT operations and eliminate sub-optimization in the allocation of IS/IT resources. This is achieved through standardizing IS/IT processes across the enterprise.

The firm that employs input standards will achieve economies of scale; input and output standards will achieve both economies of scale and scope; while the firm that employs all types of standards will achieve all three economies. Of course the firm that chooses not to standardize will not achieve any of the economies. Managers will therefore choose to employ IS/IT standardization only if they desire the economies provided by the standardization and expect to achieve economies in excess of the costs associated with creating and enforcing the standard.

When organizational demand for synergy is high and there is low demand to support a large number of unique business unit needs, managers will choose to standardize inputs, processes, and outputs to achieve all of the economies. This is the case because the potential benefit from creating these economies, or synergies, is high (evidenced by the fact that there is a strong corporate demand for synergy) and the costs of creating and enforcing the standards are relatively low. When the opposite is true – or there is a low demand for IS/IT synergy and IS/IT must service a large number of unique business unit needs – then one would expect to see no standardization. This is due to the fact that the benefits of standardizations are low (otherwise there would be demand for IS/IT synergies) and the costs of creating and enforcing standards are relatively high.

When organizational demand for IS/IT synergy is high and IS/IT must support a large number of unique business unit needs, one would expect to see both input and output standards; because the benefits from economies of scale and scope will outweigh the costs of creating and enforcing the standards. Additionally, in determining that the need for synergy is high, managers have determined that the benefits from achieving economies of scope exceed the costs of creating a perhaps complex set of standards that may be costly to enforce.

Finally, when organizational demand for synergy is low and IS/IT does not need to support a large number of unique business unit demands; managers will choose to create and enforce input standards. In such organizations it has been determined that economies of scope are low (otherwise the demand for synergy would be high), however the costs of creating and enforcing standards are also low due to low demand to support unique business unit needs. Thus, in an effort to minimize organizational IS/IT costs, input standards are implemented to generate economies of scale.

Organizational Architecture

There is a large body of literature related to the second component of integrating architecture, organizational architecture. IS/IT organizational architecture has traditionally been conceptualized as IS/IT organizational structure (Agarwal and Sambamurthy, 2002). Many researchers who have studied IS/IT structure have adopted a contingency approach which highlights the need for managers to design IS/IT structures so that the behaviors of IS/IT employees are consistent with desired organizational outcomes for IS/IT (Allen and Boynton, 1991; Zmud, 1984). Research has also been conducted to describe the contingency factors that influence IS/IT structural choices (Ahituv, et al, 1989; Brown and McGill, 1998; Ein-Dor and Segev, 1982; Olsen and Chervany, 1981; Sambamurthy and Zmud, 1999; Tavakolian, 1987). Some of the factors identified in this literature include industry, firm size, corporate strategy, and corporate structure.

Structure is most often operationalized in terms of who controls IS/IT decision-making (Brown and McGill, 1998). Sambamurthy and Zmud (1999) identify three types of IS/IT decisions that are made in organizations: infrastructure, use, and project management. Infrastructure refers to decisions made concerning hardware and software platforms as well as network and data architectures. IS/IT use refers to decisions concerning long and short-term plans for applications, and day-to-day operations and services. Project management consists of decisions related to the acquisition, development, and deployment of IS/IT applications within the organization. Sambamurthy and Zmud (1999) further identify three sets of stakeholders that may lay claim to control these decisions: corporate IS, divisional IS, and line managers. For simplicity, we conceptualize these stakeholders into two camps: corporate IS/IT and business unit IS/IT. We lump both divisional IS/IT and line managers into business unit IS/IT since both reside within the business unit. Corporate IS/IT refers to those stakeholders that reside in the corporate IS/IT function.

There are three generic models of IS/IT structure which can be described in terms of the locus of control for IS/IT: centralized, decentralized, and federal (Allen and Boynton, 1991; Sambamurthy and Zmud, 1999). In the centralized IS/IT structural model, the locus of control for all three elements (infrastructure, use, and project management) is concentrated in the corporate IS/IT function. In the decentralized model, the locus of control for all three elements is distributed into the hands of business unit managers. There are many variations of the federal model. The defining characteristic of these models is that neither corporate IS/IT nor business unit managers control all three elements.

We identify four models of IS/IT organizational architecture (see Figure 3) that are likely to occur: the centralized model, the decentralized model and two federal models. Infrastructure is centralized in both federal models. In the first federal model, use and project management are controlled at the business unit level. In the second federal model, control of both use and project management are shared between corporate and business unit managers.

Centralized Model	**Decentralized Model**
Infrastructure – Corporate IT **Use –** Corporate IT **Project Management –** Corporate IT	**Infrastructure –** Business units **Use –** Business units **Project Management –** Business units
Federal Model A	**Federal Model B**
Infrastructure – Corporate IT **Use –** Business units **Project Management –** Business units	**Infrastructure –** Corporate IT **Use –** Corporate IT/Business units **Project Management –** Corporate IT/Business units

Figure 3. Models of IS/IT Organizational Architecture

Organizations with high demand for IS/IT synergy and low need to support unique business unit needs will choose to optimize at the corporate level and select the centralized structure. Organizations with low demand for synergy and a significant need to support a large number of unique business unit needs will choose to optimize at the business unit level and select the decentralized structure. Organizations with the other two profiles will choose one of the two federal structures.

Organizations with low demand for synergies and where IS/IT does not need to service unique business unit demands will choose a federal architecture where control of use and project management is in the hands of business units (Federal A). Organizations with high demand for synergies and where IS/IT must support a large number unique business unit demands will choose a federal architecture where control of use and project management is shared between corporate IS/IT and business units (Federal B).

THE TYPOLOGY

We develop a typology of IS/IT architecture based on technical, organizational and relational architectures. The four types of architecture are described below (see Table 1). Each type corresponds to one of the four organizational categories of organizational demands for IS/IT within the organization (Figure 1).

Dimensions	**Local Architecture**	**Ad hoc Architecture**	**Partner Architecture**	**Uniform Architecture**
Organizational Demands on IS/IT	Low Synergy; High Unique BU Needs	Low Synergy; Low Unique BU Needs	High Synergy; High BU Unique Needs	High Synergy; Low Unique BU Needs
Technical Architecture	No Standardization	Input Standardization	Input and Output Standardization	Input, Output, and Process Standardization
Organizational Architecture	Decentralized	Federal A	Federal B	Centralized
Relational Architecture	Fully External Dynamic	Inter-organizational Dynamic	Inter-organizational Stable	Fully Internal Stable

Table 1 – IS/IT Architecture Types

Local Architecture

Organizations with a local architecture are characterized by little or no coordination of IS/IT among business units. As such, these organizations employ a technical architecture characterized by no standardization and a decentralized organizational architecture. Because there is little or no interdependence of IS/IT among business units and there is little IS/IT asset specificity, there is a fully external dynamic relational architecture. This architectural choice is considered the most responsive to the needs of individual business units and the least responsive to the global needs of the organization. It is therefore well suited to organizations with a low demand for IS/IT synergy and with a high demand to support a large number of unique business unit needs.

Ad hoc Architecture

Organizations with an ad hoc architecture are characterized by modest levels of coordination of IS/IT among business units. As such, these organizations employ a technical architecture characterized by input standardization and a federal organizational architecture where infrastructure is controlled by corporate IS/IT, but IS/IT use and project management are control by business units. Because there are only modest levels of interdependence of IS/IT among business units and of IS/IT asset specificity, there is an inter-organizational dynamic relational architecture. This architectural choice is responsive to the needs of individual business units, but somewhat unresponsive to the global needs of the organization. The ad hoc architecture is well-suited to organizations with a relatively low need to create IS/IT synergies, and that support relatively few unique business unit needs. In such organizations, the modest level of standardization and control of corporate IS/IT is often a result of efforts to limit IS/IT costs associated with purchasing and supporting multiple platforms and technologies rather than to create any true integration across the enterprise.

Partner Architecture

Organizations with a partner architecture are characterized by moderate to high levels of coordination of IS/IT among business units. As such, these organizations employ a technical architecture characterized by output standardization and a federal organizational architecture. Because there are moderate to high levels of interdependence of IS/IT among business units and IS/IT asset specificity, there is an inter-organizational stable relational architecture. This architectural choice is somewhat unresponsive to the needs of individual business units but it is responsive to some of the global needs of the organization. This architecture works well for organizations that need to support both high corporate demands for synergy and unique business unit needs. It allows firms to share information across the enterprise and enables business units to adapt IS/IT to fit individualized needs within corporate guidelines.

Uniform Architecture

Organizations with a uniform architecture are characterized by high levels of coordination of IS/IT within the organization. As such, these organizations employ a technical architecture characterized by high levels of standardization and a centralized organizational architecture. Because there are high levels of interdependence of IS/IT among business units and IS/IT asset specificity, there is a fully internal stable relational architecture. This architectural choice is considered the least responsive to the needs of individual business units and the most responsive to the global needs of the organization. It is most appropriate for organizations with a high need to create synergy but with low demands to support unique business unit needs.

CONTRIBUTIONS TO PRACTICE AND THEORY

This research makes several important contributions to the body of knowledge in IS/IT research. First, it increases our understanding of the construct of IS/IT architecture. The current IS/IT research is incomplete and deals with elements (technical, organizational, and relational architectures) of architecture separately; providing a fragmented view of the choices that firms make. We provide a comprehensive view of IS/IT architecture which relates architectural choices to organizational demands for IS/IT. Second, we provide a common language and framework from which future research on IS/IT alignment can be executed with a clearer conceptualization of IS/IT architecture and the relationship of this architecture to the firm and competitive environment.

Underscoring the arguments presented in the description of the typology, is the proposition that there are optimal IS/IT architectural choices managers should make given organizational demands for IS/IT. We argue that those organizations which adopt an appropriate IS/IT architectural position given the organizational demands placed on IS/IT will experience the highest levels of IS/IT performance. This is an open hypothesis that must be validated in subsequent empirical research. There are other factors that likely influence the appropriateness of an IS/IT architectural choice. Additional research should be conducted to identify these factors and illustrate the effects of these contingencies on the appropriateness of architectural choice.

To extend the work presented in this paper, we are working to validate the proposed typology and examine the relationship between architectural choice and performance. We are in the process of collecting survey responses from large companies to

determine each firm's position with respect to technical, organizational, and relational architectures. We will utilize this data to assess the validity of the typology. Utilizing q-methods, such as cluster analysis, we will empirically determine patterns of architecture that exist in the organizations we survey. The extent to which the patterns we find in the data match the profiles specified in the construction of the typology, we will receive empirical support for the typology. Additional validation will come as we assess the relationship between architectural choices and performance. Using the data described above and an independent measure of IS/IT performance, we assess this relationship with regression techniques. After classifying each organization with respect to the organizational demands placed on IS/IT, we will measure the Euclidean distance between each organization and the architectural types that we hypothesize to be most appropriate for that organization given the profile of demands that are placed on IS/IT by the organization. We expect to find that the distance measure between the actual and the ideal types of architecture to be significantly, and inversely, related with IS/IT performance.

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