Engendering Organizational Technical Capabilities and Business Capabilities by Fabricating the Operating Environments that Comprise IT Infrastructure

ABSTRACT

With information technology (IT) infrastructure serving as a foundation for much of the managerial and operational activities occurring in organizations, investment decisions targeted at enhancing or reengineering IT infrastructures are increasing in frequency, dollar amount and importance. However, current conceptualizations of the nature and value relevance of IT infrastructure remain rather limited, resulting in proponents of IT investment proposals finding it challenging to build convincing business cases for these investments. We offer new conceptualizations of IT infrastructure and its value relevance that move beyond portraying IT infrastructure as a broad collection of technical assets and services to a portrayal of IT infrastructure as a mindfully-determined aggregation of technical operating environments and business operating environments, which in turn engender specific value-adding technical and business capabilities. Next, we apply this conceptualization in synthesizing extant research examining the value-adding role of IT infrastructure across three distinct IT activity domains (solution identification, solutions delivery, and solutions execution), concluding the analysis within each domain with assessments of progress and suggested future research directions. Finally, after reiterating our theoretical contributions, we suggest research directions that apply across all three IT activity domains and discuss the implications of our ideas to practice.

Keywords: information technology infrastructure, business capability, contingency effect, business value of information technology

Engendering Organizational Technical Capabilities and Business Capabilities by Fabricating the Operating Environments that Comprise IT Infrastructure

INTRODUCTION

Information technology (IT) infrastructure serves as a core enabler of much of the work activities that occur in organizations. As a consequence, decisions to invest in new or enhanced IT infrastructure are critical business decisions with considerable operational, strategic and financial implications. According to a recent report from the U.S. Census Bureau, U.S. businesses spent $264.2 billion on IT infrastructure in 2007, an increase of 4.4% from the previous year (U.S. Census Bureau, 2009). And, according to a 2005 survey (Weill and Aral, 2006), this on-going investment reflects roughly 46% of the typical firm's overall investment in IT assets. Such expenses are expected to continue – if not grow – even in economic downturns as IT infrastructure often proves to be a key driver in efforts to reduce business costs, improve business productivity and assure unfailing business operational performance (McGee, 2008).

Relative to IT investments enabling specific operational, managerial or strategic actions, the value relevance of IT infrastructure investments are far less transparent given their indirect and typically distal relationship with key organization performance metrics. Still, empirical evidence has made it quite clear that organizations holding more sophisticated understanding of the nature and performance impacts of IT infrastructure tend to harvest greater value from their IT investments (Ross et al., 2006; Weill and Broadbent, 1998).

Given its foundational nature and importance, it might be expected that the information systems scholars would have developed rich, robust conceptualizations of the nature and value implications of IT infrastructure – conceptualizations allowing both technology executives and business executives to better appreciate the value-adding role of IT infrastructure and, hence, to be convincing and confident in arguing business cases for IT infrastructure investments. With a few notable exceptions, our examination of the research literature reveals that rich, robust theoretical conceptualizations of the nature and value implications of IT infrastructure are lacking.

Much of the scholarly research on the value relevance of IT infrastructure involves statistical analyses of the relationship between investments in IT infrastructure assets (e.g., PCs, servers, etc.) and various aspects of organization performance. While this research has provided a cumulative body of evidence that positive relationships do exist (e.g., Armstrong and Sambamurthy, 1999; Brynjolfsson and Hitt, 1996; Chatterjee et al., 2002; Zhu and Kraemer, 2002), such 'black box' examinations have not provided sufficient insight into either the nature of IT infrastructure or its value-adding roles.

Recent scholarly research applying more sophisticated views of the value relevance of IT has surfaced three key observations that have been influential in the development of our ideas. First, IT assets are increasingly conceptualized as integral elements of value-adding organizational resource sets composed of complementary IT assets and business assets (Melville et al., 2004; Wade and Hulland, 2004). As pointed out by Wade and Hulland (2004, p.123), "resources rarely act alone in creating or sustaining competitive advantage…IS resources…in almost all cases, act in conjunction with other firm resources to provide strategic benefits." Second, a small but steadily increasing number of studies has demonstrated the mediating role served by business capabilities with regard to the 'IT investment → organizational performance' relationship (Pavlou and El Sawy, 2006; Rai et al., 2006; Rai and Tang, 2010; Ross et al., 1996; Saraf et al., 2007; Ward and Zhou, 2006). For example, Pavlou and El Sawy (2006) demonstrate that specific IT capabilities (i.e., project and resource management systems, knowledge management systems, cooperative work systems) do not by themselves directly improve new product development outcomes but instead are fully mediated by new product development capabilities. Third, internal and external organizational environments have been recognized as important contingencies in explaining the value relevance of IT (Melville et al., 2004; Oh and Pinsonneault, 2007; Wade and Hulland, 2004). Inspired by these more recent contributions, this essay develops an enriched conceptualization of how IT asset and business assets complementarities, the mediating role of business capabilities, and contextual contingency factors manifest themselves in characterizing the value-adding role of IT infrastructure. Then, this enriched conceptualization is applied to synthesize extant empirical research, producing both an assessment of current progress and suggestions for future research.

Our ideas embody three specific theoretical contributions. First, we introduce the operating environment construct as a conceptual means of tangibly representing the discrete, instrumental collections of complementary assets that comprise an IT infrastructure. Second, we view IT infrastructure as consisting of a technical platform, comprised of technical operating environments, and a business platform, comprised of business operating environments. Technical operating environments, fabricated from IT assets, provision technical capabilities. Business operating environments, fabricated from IT assets, technical capabilities and business assets, provision business capabilities. Third, we expand the domains of IT-related activities associated with IT infrastructure investment by considering the solution identification (i.e., activities associated with identifying new technical and IT-enabled business solutions) and solution deliver (i.e., activities associate with acquiring and developing technical and IT-enabled business solutions) domains along with the solutions execution (i.e., activities associated with operating installed technical and IT-enabled business solutions) domain. Prior IT infrastructure research has typically been restricted to the solutions execution domain, unnecessarily limiting our collective understanding of the value-adding roles of IT infrastructure.

The remainder of this essay is organized around four tasks. First, we offer a definition of IT infrastructure that is more comprehensive than existing definitions and that provides a more realistic portrayal of the IT infrastructures observed in today's organizations. Second, we develop a theoretical conceptualization of the value-adding role of IT infrastructure that draws on the resource-based view of the firm and on contingency theory. Third, we apply this conceptualization in synthesizing extant research across the three IT activity domains. Finally, we discuss the implications of our theoretical contributions and our research synthesis.

THE EVOLVING BREADTH AND COMPLEXITY OF IT INFRASTRUCTURE

We build on prior research that has defined IT infrastructure in terms of its nature and its components. In describing the nature of IT infrastructure, scholars have focused on four primary characteristics (see Table 1), with the first two regularly voiced and the latter two less so but just as important. First, IT infrastructure is *foundational* in that it represents resource configurations whose business value is not direct but rather indirect, occurring through functionalities applied to deliver value-adding capabilities across a variety of technical and business-related activities. For example, Zhu (2004) views IT infrastructure as a firm's technology platform as well as its information foundation, and Aral and Weill (2007) point out that IT infrastructure provides a foundation for delivering IT services. Second, IT infrastructure is conceptualized as resource configurations that, primarily, are *shared* across an organization's operating units rather than as resources supporting a single (or, a limited number of) technical or business activities, and hence possess high leveragability across an enterprise (Ray et al., 2005; Star and Ruhleder, 1996). Third, IT infrastructure is seen as resource configurations characterized by *enduring* effects rather than resource sets whose value depreciates quickly. For example, Star and Ruhleder (1996) describe its temporal scope as being extended in that it does not have to be reinvented or reconfigured with each subsequent business initiative, and Weill and Broadbent (1998) portray IT infrastructure as an asset whose impact on shareholder wealth is long-term. Fourth, given an objective of leveraging IT infrastructure resource sets as fully as possible, it is most frequently characterized as being *centrally-managed.* Historically, an organizations' central IT function was typically portrayed as 'owning' IT infrastructure resources. Increasingly, however, the central IT function carries out these responsibilities in partnership with internal stakeholders, e.g., operational and staff business managers/executives (Kettinger et al., 2010), and external stakeholders, e.g., IT service providers (Iyer and Henderson, 2010). Regardless as to where authority for IT infrastructure resources lays, the central IT function is invariably understood as serving a singular guardianship role of ensuring that the IT infrastructure is cost-effective, secure, reliable, available and supportive of an organization's operations and strategies (Broadbent et al., 1999; Weill and Broadbent, 1998).

----- Insert Table 1 Here -----

Prior definitions of IT infrastructure also specify the assets types comprising these resource configurations. Implicitly premising a knowledge-based view (Grant, 1996) of firms, the resources comprising the IT infrastructure have moved beyond a focus on hardware, software, and data assets to incorporate human, intellectual (i.e., the knowledge embed in processes and designs) and relational assets. These intangible IT assets are just as meaningful, if not more so, than physical assets given their inextricable roles with the sourcing, development, transferring and integration of technical capabilities and business capabilities (Bendoly et al., 2007; Bharadwaj, 2000; Ross et al., 1996; Saraf et al., 2007; Taylor and Helfat, 2009). Synthesizing what others have collectively said (see Table 2), we identify six asset types:

- *Physical assets* represent the hardware (including embedded software) and facilities comprising the physical presence of IT infrastructure.
- *Data assets* represent collections of numbers, characters, images and other symbolic forms that are captured, created and/or stored for use in carrying out (technical and business) operational and decisional activities.
- *Design assets* represent instrumental specifications, e.g., software code, architectures, methodologies, standards, policies, procedures, etc., that define and direct: the categorization, storage, processing and dissemination of data, information and knowledge; the deployment of physical IT assets, technical services and of IT-enabled business solutions; and, the behaviors of actors engaged in IT-related activities.
- *Administrative assets* represent the processes and structures associated with the management, configuration, operation and support of delivered IT-enabled capabilities. Examples include, among many others, processes such as capacity planning, budgeting, cost recovery, purchasing, and password administration as well as structures such as steering committees, project teams, and oversight boards.
- *Human assets* represent the personnel whose efforts, skills, knowledge, and experience is invaluable in directing, configuring, operating, and supporting the delivery of IT-enabled capabilities. A variety of organizational roles are represented, including but not limited to: technical strategists, business strategists, technical architects, business process architects, system analysts, business analysts, etc.

- *Relational assets* represent the social relationships developed and nourished by the actors involved in directing, configuring, operating, and supporting the delivery of IT-enabled capabilities. Examples of key relationships include those between IT executives and business executives (e.g., Chan, 2002), IT account managers and operating managers (e.g., Clark et al., 1997), IT systems analysts and business analysts/professionals (e.g., Nelson and Cooprider, 1996), and IT managers and IT vendor managers (e.g., Ghosh and Scott, 2009).

----- Insert Table 2 Here -----

Our portrayal of IT infrastructure, while firmly grounded by the early perspectives dominated by hardware and software assets, accommodates the ever-increasing breadth and complexity of today's IT infrastructure. In order to succeed in the digital economy, organizations are required to "creatively and quickly combine IT assets with deep pools of business knowledge and competencies, fine-tuned business processes and rich networks of business relationships." (Sambamurthy and Zmud, 2000, p.106) This in turn demands a simultaneously tight and adaptive IT infrastructure comprised (conceptually) of a technical platform and a business platform.

The *technical platform*, comprised predominantly of technology-related (physical, data, design, administrative, human, and relational) assets, represents what is traditionally referred to as IT infrastructure. Within a technical platform, technology-related asset types are configured to form a broad variety of *technical operating environments*. We define an operating environment as a collection of assets and capabilities engineered to perform a specified, but limited, functionality set that is foundational, shared, enduring, and centrally-managed. We define a technical capability as the engineered, systemic functionality, emerging from configured technology-related assets, whose properties go beyond (Mutch, 2010) the fungible functionalities of constituent assets. Technical operating environments provide numerous and varied sets of technical capabilities applied, directly and indirectly, in addressing organizations' needs, problems and opportunities and problems. Such sets of technical capabilities have been referred to as IT infrastructure shared services (e.g., Aral and Weill, 2007; Armstrong and Sambamurthy, 1999; Broadbent et al., 1999). For example, a data access service (that provides entities from across an enterprise the capability to easily access data while accommodating security and compliance requirements) is configured from a variety of technology-related assets, e.g., data architects, data schemas, data administration processes, database management software, data storage devices, network communication channels, data access security mechanisms, database software training, etc.

The *business platform* – configured from technology-related assets, technical capabilities, *and* business-related assets – supports or enables business capabilities rather than technical capabilities. The business platform consists of a broad collection of *business operating environments*, each of which is engineered to provide a specified business-oriented functionality set, from which existing business capabilities are executed and enhanced and from which new business capabilities are shaped. As with technical capabilities, business capabilities provide engineered, systemic functionalities, emerging from configured technology-related assets, technology capabilities and business-related assets, whose properties go beyond the functionalities of constituent elements. For example, by configuring together a data access technical capability along with other technology-related assets and other technical capabilities and salient business-related assets, e.g., business data, business rules, business analytical models, the insights provided by business analysts, etc., a business operating environment enabling a business intelligence capability is provisioned. Today, an ever-increasing variety of business operating environments (not infrequently instantiated through enterprise system implementations) facilitate an ever-enlarging number and variety of organizational work activities: transaction environments, collaboration environments, project management environments, business intelligence environments, global business process environments, executive information environments, work flow environments, etc., to name but a few.

That today's IT infrastructures are comprised of a technical platform and a business platform is reflected in Ross's (2003) stage-model depiction of enterprise architecture evolution. Here, Ross's second 'IT Efficiency' stage refers to a rationalization of the technical platform while Ross's third 'Process Optimization' stage refers to a rationalization of the business platform.

The above discussions lead to the following definition of IT infrastructure: *assemblages of technical operating environments (configured from technology-related assets and technical capabilities) and business operating environments (configured from technology-related assets, technical capabilities and business-related assets) that are foundational, shared, enduring, and centrally-managed.*

CONCEPTUALIZING THE VALUE-ADDING ROLE OF IT INFRASTRUCTURE

Two complementary theoretical lenses are particularly meaningful in understanding the value-adding role of IT resources (Oh and Pinsonneault, 2007): the resource-based view and the contingency perspective. With the *resource-based view of the firm (RBV)* a firm's resource endowments as represented as primary sources of competitive advantage (Barney, 1991): it is by accumulating and exercising valuable, rare, costly to imitate, and nonsubstitutable resources that firms are able to achieve and sustain superior performance. Since the mid-1990s, RBV has been applied in information systems research to explain the relationship between IT investment and organization performance outcomes (Nevo and Wade, 2010; Wade and Hulland, 2004).

Much of the extant research examining the business value of IT infrastructure has applied RBV, either explicitly or implicitly, as a primary theoretical lens. Table 3 organizes, by IT infrastructure asset type, the findings from organizational-level examinations of a *direct relationship* between IT infrastructure investment and organization performance. While such studies provide cumulative evidence supportive of a positive association between IT infrastructure assets and organization performance, they have generally failed to provide explanatory insight into how performance gain materializes.

----- Insert Table 3 Here -----

More recently, information systems scholars applying the RBV in studying the business value of IT have enriched their theoretical models in two ways. First, the resource endowments characterizing IT infrastructure have been partitioned into IT assets and IT capabilities with assets seen as resources used in creating, producing and delivering an organization's market-focused products/services and capabilities seen as the capacity to deploy these resources in value-adding ways (Ethiraj et al., 2005; Wade and Hulland, 2004). Generally in such analyses (Aral and Weill 2007; Powell and Dent-Micallef 1997; Ravichandran and Lertwongsatien, 2005; Ray et al. 2005), what we term physical, data and design assets are seen as representing IT assets and what we term administrative, human and relational assets are seen as representing IT capabilities. (Note that this use of the term IT capability is slightly different from our technical capability that refers to the functionality (or functionalities) produced by a technical operating environment.) Second, following a logical chain that capabilities are the mechanisms by which assets are deployed, IT assets and IT capabilities are modeled as complementary in influencing business value; that is, increases in business value are proposed to be greater for those organizations investing more in *both* IT infrastructure assets *and* IT infrastructure capabilities**.** Following Nevo and Wade (2010), we recognize as well that technology-related resources are as well synthesized in a complementary manner with business-related resources to fabricate unique, value-adding resource sets. More specifically, our introduction of the operating environment construct richly incorporates the notion of resource complementarity – enabling scholars to break with a commodity-like view of the resources comprising IT infrastructure and instead to delve into the black-box of how technology-related assets and technical capabilities are deliberately combined in configuring technical operating environments and how technology-related assets, technical capabilities, and business-related assets are deliberately combined in configuring business operating environments.

The *contingency theory perspective* emphasizes the necessity for a firm to align its resource endowments with the character of its environment (Doty et al., 1993). When applied by information systems scholars, the contingency perspective has motivated attention to achieving alignment (e.g., Chan et al., 1997; Parthasarthy and Sethi, 1992; Sabherwal and Chan, 2001; Sabherwal and Kirs, 1994) between IT activity sets, e.g., IT strategies, structures, priorities, initiatives, etc., and business activity sets, e.g., business strategies, structures, priorities, initiatives, etc. Although a contingency perspective has not served as a dominant lens in examinations of the value-added nature of IT infrastructure, a few studies have included contingency factors. For example, Sircar et al. (2000) take industry into account in analyzing the impact of IT infrastructure on firm performance outcomes, finding that investments in physical IT assets had positive impacts on performance outcomes in all sectors except retail sales. Similarly, Zhu and Kraemer (2002) dichotomized their data by industry context, e.g., high-tech versus traditional manufacturing, finding that heightened investment in IT infrastructure reduced cost of goods sold only for high-tech firms.

The Mediating Role of Business Capabilities

We begin by describing the mediating role served by business capabilities in the influence of IT infrastructure on organizational performance (see Figure 1). After describing with more depth two of the constructs in Figure 1, i.e., business capabilities and organizational performance, each of the noted relationships (1, 2, 3, 4, 5 and 6) are discussed.

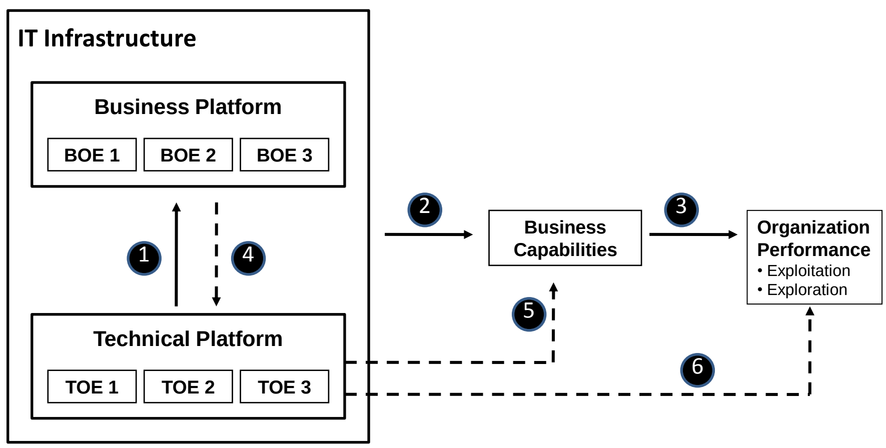

Figure 1. Value-Adding Role of IT Infrastructure
(BOE: Business Operating Environment; TOE: Technical Operating Environment)

Building from the strategic management literature (Coff, 2010; Ethiraj et. al., 2005), we portray *business capabilities* as competencies (delivered or potential) that enable an organization to deploy its resources, both commodity-like and differentiated, in ways that are valued by influential stakeholders. Successful organizations develop business capabilities to plan current and future operations, to create the products and services valued by stakeholders, to carry out day-to-day operations, and to reassess the appropriateness of enacted plans, product/service portfolios and operations given environmental changes (Teece, 2007).

Organization performance captures the value-relevant outcomes associated with an organization's deployed business capabilities. Ultimately, the favorableness of performance is a function of the extent stakeholders value achieved outcomes, both short- and long-term. Given the diversity that exists across organizations' stakeholders, executive leadership teams recognize the necessity to assess performance through a well-thought constellation of performance metrics (Kaplan and Norton, 1993, 1996, 2005). Not surprising, information systems scholars examining performance-related outcomes associated with information systems activities have similarly applied a variety of organization performance metrics. In order to reduce the complexity inherent in this plethora of performance measures, we apply the exploitation/exploration distinction as an organizing frame. Organization science scholars now generally concur that maintaining an appropriate balance between attending to an organization's current performance (i.e., fully leveraging current capabilities) and anticipated future performance (i.e., building and positioning future capabilities) is critical for the organization's prosperity and survival (Benner and Tushman, 2003; Gupta et al., 2006; He and Wong, 2004; March, 1991; Uotila et al., 2009). Recent information system research as well recognizes the salience of these two aspects of performance (e.g., Kane and Alavi, 2007). While the exploitation/exploration dichotomy initially emerged to represent both the activities and outcomes associated with organizational learning and innovation, recent research has extended its application to a broad range of organizational activity domains (Farjoun, 2010). This extended view of the exploitation/exploration conceptual frame has enabled more robust empirical analyses of the trade-offs between short-term and long-term performance impacts of a broad range of organizational activities across different companies and industries (Uotila et al., 2009). Our use of the exploitation/exploration conceptual frame is grounded in this extended view.

Exploitation refers to "…such things as refinement, choice, production, efficiency, selection, implementation, execution (March, 1991, p.71)." Performance metrics in information systems research related to exploitation include IT-focused metrics (e.g., system response times, system availability, proportion of projects on time and within budget, software defect rates, systems development process maturity, etc.) and organization-focused metrics (operating costs, return on assets, customer satisfaction, etc.). In contrast, exploration refers to "…things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation (March, 1991, p.71)." Performance metrics used in information systems research related to exploration again have included IT-focused metrics (e.g., number of IT-enabled strategic initiatives proposed, IT professionals' business knowledge, IT adoption and diffusion, etc.) and organization-focused metrics (e.g., sales growth, number of new products developed, etc.).

Returning to Figure 1, the principal value pathway within our conceptualization is that denoted by solid-line relationships, i.e., relationships 1, 2 and 3. The linkage from the technical platform to the business platform (relationship 1) indicates that many, if not a majority, of the assets and capabilities used in fabricating business operating environments are elements of technical operating environments. For example, in building an enterprise database many technology-related assets (e.g., storage devices, servers, data management software, data architectures, etc.) and technical capabilities (e.g., data migration services, data security services, data administration services, etc.) are combined with business-related assets (business data, business data ownership policies and procedures, data capture routines, etc.). Increasingly, these IT-enabled business operating environments are being configured as enterprise resources (i.e., robust operating environments whose functionality can be leveraged at a reasonable cost by many, if not all, of an organization's work units) and are acquired from third-parties in the form of packaged solutions. The installation of such a shared resource invariably requires changes, often substantial, to an organization's prior technical and business operating environments.

The linkage from the business platform to business capabilities (relationship 2) emphasizes that the primary objective in building a business operating environment lies in the enablement of one or more business capabilities. Organization science research has identified that configuring and combining bundles of assets and capabilities in fashioning value-adding business capabilities occurs through two pathways (Ethiraj et al., 2005): learning-by-doing and deliberate investment in organizational structures. Learning-by-doing reflects the passive accumulation of experience that is embedded in routines and procedures (i.e., incrementally instantiating a business functionality set over time) whereas deliberate investment in organizational structures (i.e., the acquisition and/or fabrication of a pre-defined business functionality set) reflects a more proactive approach to providing enhanced, or new, routines and practices. Both pathways are present in organizations' efforts to deploy IT resource sets such that these deployments align with organizational strategies, tactics and operations (Oh and Pinsonneault, 2007).

The linkage from business capabilities to organization performance (relationship 3) denotes that business capabilities, particularly those that are rare or otherwise difficult to acquire and configure, directly influence organization performance (Coff, 2010; Picolli and Ives, 2005; Rumelt, 1987). For example, higher levels of project management and project resource management capabilities can enable a software vendor to accurately assess the resource inputs needed for a project aimed at developing a new generation of products and to ensure the effective deployment of these resources in executing associated product development activities. This in turn can contribute to the profitability of the new software product by reducing first-copy development costs and by introducing the new product into a marketplace before competitors (hence enjoying a longer period of extraordinary margins). Recent information systems research has begun to provide evidence supportive of this notion that it is through the engendering of business capabilities that business value is appropriated from IT investments (see, for example, Pavlou and El Sawy, 2006; Rai et al., 2006; Rai and Tang, 2010; Saraf et al., 2007; Ward and Zhou, 2006).

We also recognize that organizations deploy IT infrastructure assets and capabilities in ways other than value pathway denoted as relationships 1, 2 and 3 in Figure 1. Three instances of such behaviors are particularly prevalent (depicted as dashed-line relationships 4, 5, and 6). First, firms can fabricate new technical capabilities from the functionality sets afforded by business operating environments (relationship 4). For example, a business forecasting capability provided through a business operating environment established to support business strategic activities and product planning activities can also be used to support technology forecasting associated with network, server or data storage capacity planning. Second, localized business capabilities may initially be configured directly from functionalities enabled through one or more technical operating environments (relationship 5). For example, a 'live-chat' business capability can be created to enrich a business unit's customer support operation by configuring already-existent communication technical capabilities. However, as other work units begin to recognize the value of this localized business capability, it is likely that a business operating environment enabling the capability would be established. Third, the functionality enabled by a technical operating environment may directly impact organization performance (relationship 6). In practice, such relationships are most commonly observed with technology initiatives aimed at simultaneously reducing the cost and improving the performance of heavily-used technology assets and services, e.g., outsourcing much of an organization's IT infrastructure operations and management can dramatically reduce overall cost structures (Hawk et. al, 2009).

While acknowledging the existence of relationships 4, 5 and 6, our focus with the remainder of the essay is directed at relationships 1, 2 and 3 for two reasons. First, restricting the scope of our analysis substantially reduces its complexity. Second, the pathway represented as relationships 1, 2 and 3 is representative of the steady-state IT infrastructure conditions most likely to be examined in empirical scholarly information systems research.

THE INFLUENCE OF CONTINGENCY FACTORS

We allow for three possible venues for contingency effects to occur. In Figure 2, these venues are denoted as relationships A and B (contingency factors moderate relationships between business capabilities and organizational performance as well as between operating environments and business capabilities), relationships C and D (contingency factors serve as antecedents, respectively, to the configuration of business and technical operating environments) and relationship E (contingency factors moderate the relationship between technical operating environments and business operating environments). These contingencies follow from decisions to deploy operating environments characterized by low or high asset-specificity, as explained below.

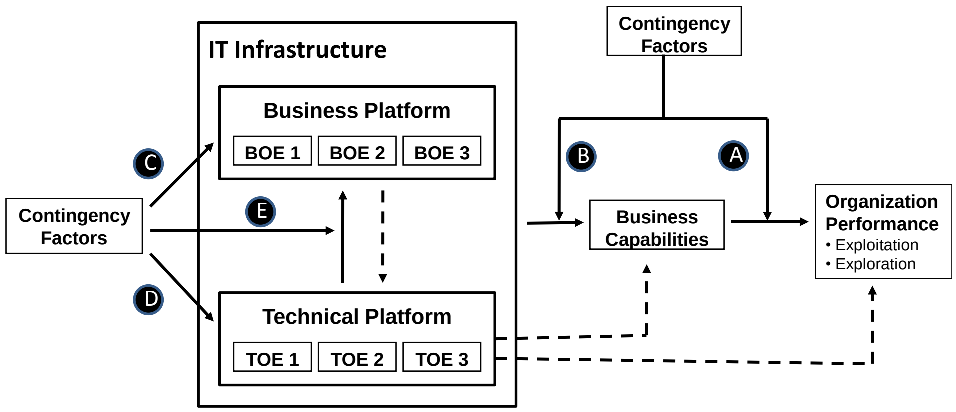

Figure 2. The Contingency Perspective
(BOE: Business Operating Environment; TOE: Technical Operating Environment)

Today, a broad variety of operating environments (especially technical operating environments but increasingly business operating environments) can be acquired from vendors and installed with minimal organization-specific configuration. Such low asset-specific operating environments may be rather generic, e.g., a Microsoft .Net development environment, or may be designed to fit the requirements of a particular category of organizations, e.g., an industry-specific variant of an enterprise system. Generally, the cost to acquire and install a low asset-specific operating environment is less than the cost to acquire and install a high aspect-specific operating environment (Nelson et al., 1996). By definition, however, low asset-specific operating environments are likely to be misaligned (in varying degrees) to aspects of adopting organizations' internal and external environments (Soh and Sia, 2005) such that the value ultimately appropriated from a low asset-specific operating environment will be contingent on the nature and extent of this misalignment. Accordingly, we expect that value derived from business capabilities enabled through low asset-specific operating environments will be moderated by salient contingencies (relationships A and B), as inferred in the earlier-referenced studies by Sircar et al. (2000) and Zhu and Kraemer (2002).

Alternatively, organizations may decide to fabricate operating environments that are explicitly configured to align, to varying degrees, with their external and internal environments. Dell, for example, has engineered a large number of highly asset-specific (technical and business) operating environments to enable the business capabilities that underlay its Direct Model (Magretta, 1998). Such practices are reflected in relationships C and D (an antecedent role) in Figure 2. When business capabilities are enabled through operating environments fabricated to account for specific contingency factors, we do not expect these specific contingency factors to moderate the appropriation of value as depicted by relationships A and B.

Finally, for completeness, we also recognize that the functionality targeted to be engineered into a business operating environment may lack sufficient alignment with an organization's (internal and external) environments because the business operating environment was supported through low asset-specific technical operating environments. Such contingencies are represented as relationship E (a moderating role) in Figure 2.

RESEARCH SYNTHESIS: EXAMINING THE BUSINESS VALUE OF IT INFRASTRUCTURE ACROSS THREE IT ACTIVITY DOMAINS

Information systems scholars generally recognize that monolithic representations of an organization's IT-related activities inadequately account for the varied contexts within which IT investments are leveraged in furthering an organization's success (Feeny and Willcocks, 1998; Sambamurthy, et al., 2003; Weill and Broadbent, 1998; Zmud, 1984). Striving for conceptual simplicity, we organize an organization's value-adding IT activities within three domains, with each domain representing a meta-value-creating process (Agarwal and Sambamurthy, 2002; Bharadwaj, 2000; Ravichandran and Lertwongsatien, 2005; Sambamurthy and Zmud, 2000; Xia and Lee, 2005):

- *Solution identification* embodies the envisioning, prioritizing, and approving of investments in technology-related assets, technical capabilities, technical and business operating environments, and IT-enabled business capabilities.
- *Solution delivery* embodies the analyzing, designing, acquiring, developing and installing of technical capabilities, technical and business operating environments, and IT-enabled business capabilities.
- *Solution execution* embodies the operating, supporting, maintaining and enhancing of technical capabilities, technical and business operating environments, and IT-enabled business capabilities.

This schema for decomposing the larger IT activity domain has its roots in Simon's (1977) three phases of managerial decision making: intelligence, design, and choice. In Simon's (1977, pp. 40-41) conceptualization, intelligence involves "… searching the environment for conditions calling for decision…", design includes "… inventing, developing, and analyzing possible courses of action …", and choice involves "… selecting a particular course of action from those available..." In essence, the intelligence phase involves creating a vision for the activity to occur, the design phase involves structuring and otherwise enabling this activity to occur, and the choice phase involves carrying out the activity. This generalized schema has been applied in framing a variety of activity domains, e.g., the 'FORMING … storming … NORMING … PERFORMING' sequence associated with small groups (Tuckman, 1965), and has been widely used in IT practice as the ‘PLAN … BUILD … RUN’ sequence associated with technology deployments (Zmud, et al., 1986).

These distinct domains of IT activity, solution identification, delivery, and execution are inherently connected via both an explicit path dependency and by learning-related feedback loops. By definition, any IT initiative must be envisioned, in whole or in part, before the processes to deliver the initiative can be put in place. Likewise, any IT initiative must be delivered, in whole or in part, before it can be instrumentally applied. We also recognized that the unfolding of an IT initiative across these three activity domains is almost never a strictly linear dynamic. Certain of the tasks associated with two or three of the activity domains may transpire in parallel, and the knowledge that accrues during the delivery and execution of an initiative can greatly influence the envisioning of subsequent versions of the initiative as well as the envisioning of different but related initiatives. Still, the realization that numerous interdependencies exist regarding these three IT activity domains does not diminish the distinct variation that exists across the tasks, participants and outcomes associated with each.

In the sections that follow, we apply our conceptualization of the value-adding role of IT infrastructure (see Figures 1 and 2) as a lens within each of these value-creating IT activity domains in order to document, interpret and synthesize extant *empirical* research examining the business value implications of IT infrastructure. Central to our analysis was the identification of the technical and business operating environments created from IT infrastructure assets and technical capabilities, the engendered business capabilities, the associated organization performance metrics and examined contingencies.

Four criteria guided our selection of empirical research studies to include within this synthesis. First, selected studies applied research designs that explicitly included IT infrastructure elements, technical and business operating environments, business capabilities, organization performance metrics, and/or contingency factors. With one exception – Ward and Zhou (2006), where it was clear that elements of the IT infrastructure elements had been deployed in configuring examined operating environments – only studies explicitly gathering data on IT infrastructure assets and operating environments were included. Second, all selected studies used research designs applying an organizational (firm or independent business unit) level of analysis. Third, selected studies applied research designs of a quantitative nature involving a (relatively) large number of observations. We thus excluded qualitative case studies and quantitative analyses involving only a small number of observations. The latter two criteria were employed to ensure a sufficient consistency across our research synthesis. Finally, we limited our literature search to seven journals that are characterized by rigorous peer-review processes and that regularly publish empirical research of a quantitative nature examining these three value-adding IT activity domains: *MIS Quarterly, Information Systems Research, Journal of Management Information Systems, Management Science, Organization Science, Decision Sciences,* and *IEEE Transactions on Engineering Management*. In synthesizing findings across the selected studies, we only took into consideration statistically significant results.

THE SOLUTION IDENTIFICATION DOMAIN

Solution identification involves the efforts of a firm's managers and professionals to (Agarwal and Sambamurthy, 2002; Sambamurthy and Zmud, 2000): conceptualize how business and IT assets can be configured to enhance business capabilities and organization performance; assess and compare alternative actions; and, commence one or more technical and/or business initiatives. The significance of solution identification lies in the direction and impetus provided for enhancing current operations and current strategic thrusts, initiating new strategic thrusts

(Rackoff et al., 1985), and creating the options foreshadowing future strategic actions (Sambamurthy et al., 2003).

The process of solution identification can be characterized as a recombinatory search in which new or enhanced business capabilities are surfaced and assessed (Schilling and Phelps, 2007). Effective solution identification relies on the cooperative participation of business managers/professionals and IT managers/professionals (Kearns and Sabherwal, 2006/2007) and on information flows that stimulate creative thinking by these participants (Lind and Zmud, 1991). Thus, engineered technical and business operating environments facilitative of solution identification are likely to focus on two objectives: providing participants with access to a variety of salient data/information/knowledge sources; and, inducing participants' interaction, collaboration, and data/information/knowledge sharing.

We identified twelve empirical studies relevant to the solution identification domain. Table 4 summarizes these studies. A single pattern is consistently evident: the enabling of a managerial interaction business operating environment that subsequently facilitates organizations' IT strategic planning capabilities. In these studies, managerial interaction operating environments were configured mostly from human and administrative IT infrastructure assets (and, in a few studies, relational assets and technical capabilities) to enable the participant data/information/knowledge exchanges that subsequently enrich the IT strategic planning processes. A general observation derived from these studies is that a well-configured managerial interaction operating environment finds technology and business professionals interacting collaboratively in a comprehensive, systematic IT strategic planning process.

----- Insert Table 4 Here -----

Only a few of the studies – the exceptions being Sabherwal (1999), Kearns and Lederer (2003), and Kearns and Sabherwal (2006/2007, 2007) – examined the relationship between IT strategic planning capabilities and organization performance. Not surprising, when this relationship is investigated, greater IT strategic planning capabilities have been found to induce higher levels of organization performance. Through the application of our conceptual lens, then, we can begin to open up the black box of how IT infrastructure contributes to business value in the solutions discovery domain.

Five of the twelve studies included contingency factors as moderating variables (Gupta and Raghunathan, 1989; Newkirk and Lederer, 2006) or antecedent variables (Kearns and Lederer, 2003; Kearns and Sabherwal, 2006/2007, 2007). With the studies taking the moderation approach, the value-adding impacts of managerial interaction operating environments on IT strategic planning capabilities were contingent on industry type or environmental uncertainty. With the studies taking the antecedent approach, the natures of configured managerial interaction operating environments were observed to be influenced by the information intensity of organizational work activities, by product-market diversity, by IT governance mode, and by top managers' held IT knowledge. Such contingency effects seem very reasonable as it seems both intuitive and pragmatic that the value to be gained from inducing rich interaction amongst IT strategic planning participants would be greatest for organizations that:

- Compete in uncertain, diverse and information-intensive competitive arenas (benefiting from frequent, meaningful dialogues about the streams of IT opportunities and problems that regularly 'pop up').

- Adopt a centralized rather than decentralized mode of IT governance (benefiting from frequent, meaningful dialogues aimed at balancing enterprise-wide and local IT needs).
- Have highly IT-literate managers (able to participate effectively in meaningful dialogues).

Our synthesis leads us to offer five suggestions for future research within the solution identification domain seeking to examine the value-adding influence of IT infrastructure on organization performance. First, while the noted studies have included IT infrastructure assets in their research models, the theoretical arguments relating IT infrastructure directly or indirectly to either business capabilities or organization performance have been underdeveloped, at best. Generally, IT infrastructure assets are examined either at a conceptual level above that of what we term an operating environment, i.e., as a 'black box' aggregate, or as discrete entities with little explication of how these entities are combined in fabricating the operating environments that enable the business capabilities crucial for successful solution identification. We expect that our theoretical conceptualizations will prove useful as scholars evolve more robust theoretical models for the solution identification domain.

Second, a single operating environment has been studied with regard to the solution: the managerial interaction business operating environment. In this prior work, managerial interaction operating environments are represented, as best we can interpret, as being fabricated from human and administrative assets. Rathwell and Burns (1985), among others, have argued for digitizing the strategic planning environment in a manner similar to the CASE development environments (Purvis et al., 2001) targeted at software development. Such digitized planning environments would be fabricated largely from physical, data, design, and administrative assets.

We thus suggest that research designs explaining the influence of IT infrastructure on organization performance in the solution identification domain explicitly incorporate a full range of IT infrastructure assets within the operating environments being studied.

Third, the only business capability studied was IT strategic planning capability. Business capabilities often discussed as being critical to the solution identification domain include, among others, business strategic planning (Sambamurthy et al., 2003), strategic experimentation (van de Ven, 1986; Venkatraman, 2000), and portfolio management (Sambamurthy et al., 2003; Weill and Broadbent, 1998). We especially encourage research that examines multiple business capabilities in order to gain insights into inherent complementarities.

Fourth, only three of the twelve studies in this synthesis included organization performance variables. All three studies applied perceptual measures alone, and two of these studies applied either exploitative or exploratory performance metrics but not both. Examining performance from both an exploitative lens and an exploratory lens is particularly important for the solution identification domain, given the importance of simultaneously accounting for current and future strategies in an organization's enacted strategies (Gupta et al., 2006). We strongly encourage scholars examining the value contributions of IT infrastructure within the solution identification domain to include organization performance metrics in their research designs, to apply both exploitative (e.g., time and cost efficiency of the IT strategic planning process) and exploratory metrics (e.g., number of new strategic initiatives proposed and undertaken), and to use metrics derived from both objective and perceptual data.

Finally, while only five of the twelve studies included (as either moderators or antecedents) contingency factors within their research designs, the contingencies introduced were both appropriate and effective. Incorporating contingency factors within research designs will most certainly increase a research model's explanatory power. We encourage scholars to include these and other contingencies within future research models examining the solution identification domain.

THE SOLUTION DELIVERY DOMAIN

As IT is increasingly integral to deployed business solutions, we define solution delivery as the analysis, design, and implementation of IT-enabled business solutions. In addition to activities internal to an organization, solution delivery occurs through the acquisition of packaged software, the acquisition of turnkey system integration solutions, alliances with partners in joint development initiatives, and the outsourcing of specific development activities. Solution delivery is a complex, knowledge-intensive activity (Nidumolu and Subramani, 2003/2004) involving the selection of a delivery strategy (e.g., commodity or customized, in-house or outsourced, etc.) and the organization and management of solution delivery processes. As executing such processes from scratch is both risky and costly (Nelson et al., 1996; Xu and Ramesh, 2007), the provisioning of robust, customizable operating environments for solution delivery is advocated (Chatterjee et al., 2002).

Although numerous studies have examined the solution delivery domain, most these have applied a project level of analysis. While this body of work has been extremely valuable in understanding the complexities associated with solution delivery, it is not included in our research synthesis because project level research designs typically confound IT infrastructure investment across examined projects and because much of the variance explained in such studies is accounted for by project-specific constructs. Limiting our search to the organization-level, only five studies were identified. Table 5 summarizes our research synthesis.

The extant literature highlights two primary value-adding technical operating environments: facilitating IT project management activities, and facilitating software (or component) development activities. Interestingly, the IT infrastructure elements most often associated with these operating environments have involved human, administrative, and relational assets and not – as might be expected – hardware, data or design assets. Only the study by Nidumolu and Subramani (2003/2004) explicitly incorporates a business operating environment, that of new product development. Here, though, it is noteworthy that this study involved firms competing in software product-markets. While business operating environments are not explicitly identified in the other four studies, these studies' technical operating environments implicitly contribute to a business capability of developing new or enhanced business solutions. Also evident from our synthesis is the omission, other than Nidumolu and Subramani (2003/2004), of organizational performance measures. Instead, the studies focus on capturing software development outcomes, e.g., the extent to which developed software systems have met customer/client expectations as well as time and budget targets. Finally, only Liu and Yetton (2007) employed a research design that included a contingency factor, finding task uncertainty to moderate the effects on project performance of using a project management office or project reviews.

----- Insert Table 5 Here -----

Our research synthesis leads us to suggest four research opportunities regarding the value-adding role of IT infrastructure in the solution delivery domain. First, and perhaps most important, we strongly advocate research which examines a greater variety of technical operating environments and business operating environments. In particular, while much has been written about the value of CASE-like development environments (Purvis et al., 2001), we failed to surface empirical, organizational-level studies examining performance outcomes from configuring digitized solution development environments. Also, a number of candidate operating environments in addition to IT project management (Liu and Yetton, 2007; Nidumolu and Subramani, 2003/2004) and software (component) development (Ravichandran and Rai, 2000) have been identified in related research, including software development process improvement (Harter et al., 2000; Krishnan et al., 2000), developer interaction (Slaughter and Kirsch, 2006), system lifecycle management (Ahituv et al., 1984; Rowen, 1990), configuration management (Bersoff, 1984), testing (Ahituv et al., 1984), and training (McDermott and Marucheck, 1995).

Second, while not explicitly stated, we inferred from provided arguments that the business capability targeted in these studies was that of business solution development. We encourage research designs that explicitly incorporate business capabilities salient to the solution delivery domain, such as but certainly not limited to business solution development, change management (Clark et al., 1997), solution requirements specification (Rowen, 1990), and vendor management (Hall and McCauley, 1987).

Third, we advocate research designs in the solution delivery domain that address the value relevance of operating environments and business capabilities by including organization performance measures. A rich set of exploitative (e.g., proportion of business solutions delivered on time and within budget, business solution failure rates or risk exposure, business solution process maturity, etc.) and exploratory (e.g., deploying innovative business solutions, business solution process innovation, etc.) performance metrics are available. Additionally, following Ravichandran and Rai (2000), we encourage research designs that include multiple solution delivery operating environments and incorporate interdependencies amongst these operating environments.

Finally, though only one of the five studies, i.e., Liu and Yetton (2007), included a contingency factor, solutions delivery research at a project-level of analysis suggests a number of candidate contingency factors: task complexity (Harter et al., 2000), environmental volatility (Barry et al., 2006), work dispersion (Ramasubbu et al., 2008), and organizational culture (Muller et al., 2009). It seems clear that the value relevance of solution delivery operating environments is dependent on effectively configuring operating environments that align with an organization's external and internal contexts. Accordingly, we encourage research designs that incorporate salient contingency factors.

THE SOLUTION EXECUTION DOMAIN

Solution execution refers to the operation and support of IT-enabled business solutions as well as the IT services that enabled these business solutions (Agarwal and Sambamurthy, 2002; Dixon and John, 1989). Solution execution represents not only the largest segment of organization's IT budgets (Weill and Aral, 2006) but also the IT activity domain through which value is most likely to be appropriated (Agarwal and Sambamurthy, 2002; Weill and Broadbent, 1998).

We found eleven relevant studies from the sampled journals. Table 6 summarizes our research synthesis. Six observations should be noted. First, with three exceptions (Dong et al. 2009; Malhotra et. al, 2007; Rai and Tang, 2010), only business operating environments were included in research designs. Second, one or both of two business operating environments, i.e., integrated business processes and enterprise data, were included in four of the eleven studies. Third, generally little attention was given to explaining the nature of the assets and technical capabilities combined in fabricating these operating environments. Fourth, aside from supply chain (or supply-chain related) business capabilities appearing in four studies (Bharadwaj et. al, 2007; Dong et al., 2009; Rai et. al, 2006; Ward and Zhou, 2006), the remaining business capabilities appeared in a single study each. Fifth, organization performance was included in nine of the studies with perceptual, exploitative measures dominating. Finally, only three of the fourteen studies included contingency factors: Pavlou and El Sawy (2005) used environment turbulence as a moderating factor, Dong et al. (2009) used environmental complexity as a moderating factor, and Rai and Tang (2010) used environmental turbulence and supplier concentration as moderating factors.

----- Insert Table 6 Here -----

We see five opportunities to further developing this research stream. First, we encourage researchers to explicitly incorporate within their research models the IT infrastructure elements associated with the operating environments being studied. Understanding the nature of the IT infrastructure elements, ideally specific combinations of assets and technical capabilities, is important in order to gain richer insight into both the nature of configured operating environments and the value-adding role of IT infrastructure within the solution execution domain.

Second, we encourage research designs that follow Rai and Tang (2010) by examining sets of operating environments tightly-linked to one or more business capabilities and by accounting for interdependencies amongst these operating environments and business capabilities. We expect research designs incorporating sets of complementary operating environments and business capabilities to better capture the solution execution intricacies of organizations' enacted business models (Johnson et al., 2008). We also note that the business capabilities emphasized in extant research within the solution execution domain are best characterized as involving routine work. However, arguments raised in support of IT infrastructure investments have touched on the value of enabling an organization's members to effectively and efficiently respond to nonroutine, or unexpected, work situations (Fedorowicz and Konsynski, 1992; Sambamurthy et al., 2003). We thus encourage research that examines operating environments (e.g., a virtual interaction environment) and business capabilities (e.g., an incident response capability) associated with nonroutine work.

Third, we were particularly surprised by the lack of attention given to technical operating environments in extant research on the solution execution domain. Studies aimed at better understanding the technical operating environments that underlay specific business operating environments have great potential to enhance our collective understanding of the value-adding role of IT infrastructure.

Fourth, while not diminishing the importance of studies demonstrating how IT infrastructure investment contributes to the exploitative aspects of organization performance (e.g., operation efficiency, competitive position, and market value), we could not help but notice the lack of research in the solutions execution domain examining exploratory organization performance – especially given the prevalence of arguments in the IT strategy literature (Sambamurthy et al, 2003) regarding the flexibility advantages of IT-enablement. We consequently encourage scholars examining IT infrastructure value appropriation in the solution execution domain to incorporate within their research designs exploratory performance measures, e.g., operational flexibility and scalability, number of new products developed, number of new customers or suppliers, etc.

Finally, we were also quite surprised by the lack of research designs that included contingency factors. Considerable research exists, e.g., see Chiasson and Davidson (2005) and Fichman (2004), offering compelling arguments regarding the influence of environmental, institutional and organizational factors on organizations' IT investment behaviors, adoption behaviors, and usage behaviors. Consequently, research designs incorporating relevant contingencies would be expected to better explain variations in IT infrastructure value appropriation within the solution execution domain.

THEORETICAL CONTRIBUTIONS

A key motivation leading us to examine extant information system research on IT infrastructure was the lack of consistently-agreed-to definitions of IT infrastructure. The elaborated, more finely-grained conceptualizations of the nature and elements of IT infrastructure offered herein thus represent an overarching contribution of our efforts. In addition, the intellectual journey we took led to three specific theoretical contributions and to our identification of a series of research questions of a substantive nature that, if addressed successfully, have the potential to significantly advance our collective understanding of the value-adding role of IT infrastructure.

SPECIFIC THEORETICAL CONTRIBUTIONS

Three specific theoretical contributions are introduced in our work. First, the conceptualizations offered introduce two new theoretical constructs that provide intellectual mechanisms for better describing and examining the nature and influence of IT infrastructure within organizational contexts: operating environment, and the distinction between technical operating environments and business operating environments. Second, most extant research on IT infrastructure either explicitly (less often) or implicitly (more often) associates IT infrastructure with organizations' operational activities, or what we have termed the solution execution IT activity domain. By expanding the influence of IT infrastructure beyond solution execution to include solution identification and solution delivery, the multiplicity characterizing the value-adding roles served by IT infrastructure become more apparent. Third, our research syntheses – enriched through applying a lens reflecting our new conceptualizations – clarifies the progress that information systems scholars have made in explicating the value –adding roles of IT infrastructure within the solution identification, solution delivery and solution execution domains and suggest specific research direction within each of these domains. Below, we provide expanded discussions of the first two of these contributions and offer a set of research suggestions distilled from the third contribution.

The Operating Environment Construct

In their work describing the importance of organization's designing and fashioning an apropos enterprise architecture, Ross et al. (2006) introduce the notion of an operating model. In the context of enterprise architectures, an operating model is (Ross et al., 2006): "… the necessary level of business process integration and standardization for delivering goods and services to customers ..." (p. 25) that "… drives the design of the foundation for execution ..." (p. 26). Ross et al. (2006) go on to say (p. 26):

> An operating model enables rapid implementation of a range of strategic initiatives. But that same operating model will fail to support initiatives that are inconsistent with the assumptions it's built on. Thus, the operating model is a choice about what strategies are going to be supported.

Though the Ross et al. (2006) conception of an operating model applies at a higher and more abstracted level of analysis than that associated with IT infrastructures, we recognized the relevance of these ideas to organizations' investing in their IT infrastructures to provide the foundational capabilities, through the fabrication of numerous distinct operating environments that ultimately support and enable organization performance.

Technical Operating Environments and Business Operating Environments

All too typically, IT infrastructure is brought into research models as a highly- aggregated construct rather than being decomposed into its constituent elements such that only those elements most salient to the research model are defined and included. While such instantiations of IT infrastructure may suggest the importance of IT infrastructure, it is unlikely that they will produce meaningful progress regarding enhancing our understanding of the "where, when, how and why" of the value-adding nature of IT infrastructure. It is only by decomposing IT infrastructure into clusters of interrelated but separable units such that the value relevance of discrete units or clusters can be examine that significant progress is likely to occur.

By recognizing that IT infrastructure, today, engenders both technical capabilities and business capabilities, we conceived of constituting IT infrastructure as comprised of both technical operating environments and business operating environments. Consistent with our offered definition of IT infrastructure, both technical operating environments and business operating environments are seen as foundational, shared, enduring and centrally-managed. Further, we relate these two types of operating environments hierarchically with technical operating environments being foundational to business operating environments. Scholars mindfully incorporating distinctive technical operating environments and/or distinctive business operating environments within their research models are more likely to unravel the complexities associated with the value relevance of IT infrastructure than are scholars whose research models incorporate IT infrastructure either as an aggregate entity or as a loose collection of technical assets.

Solution Identification, Solution Delivery and Solution Execution IT Activity Domains

All too typically, scholarly research examining the value relevance of IT infrastructure has singularly focused on the roles served by IT infrastructure in facilitating in the solution execution domain. We in no way diminish the importance of such a focus. However, as argued earlier, the value relevance of IT infrastructure expands beyond enabling the operation of IT-enabled business solutions to include the efforts undertaken within organizations to conceive/direct, i.e., solutions identification, and to acquire/build, i.e., solutions delivery, IT-enabled business solutions. Our review and synthesis of prior work related to both solutions identification and solutions delivery makes clear: (1) the foundational roles served by IT infrastructure in each of these domains, and (2) the rather limited ways by which IT infrastructure has been conceptualized in each of these domains. By mindfully examining the multiplicity of enabling roles served by IT infrastructure across the solution identification, solution delivery, and solution execution IT activity domains, the collective understanding that emerges regarding the value relevance of IT infrastructure promises to be both more complete and more robust.

SUGGESTED RESEARCH DIRECTIONS

So as not to repeat research suggestions already offered within our research synthesis regarding the solution identification, solution delivery and solution execution IT activity domains, our focus here is with articulating core research questions applicable to all three domains. Specifically, we encourage scholars to examine questions regarding organizations' decisions to populate their technical platforms and business platforms and to configure these operating environments as well as questions regarding the nature of the relationships between these operating environments, provisioned business capabilities, and organization performance.

Populating Organizations' Technical Platforms and Business Platforms

Extant IT infrastructure research evidences little knowledge of the natures of the distinct technical operating environments found to populate organizations' technical platforms, the technological capabilities provided through each of these technical operating environments, and the interdependencies that exist across these technical operating environments. Research examining each of these areas is needed. We further encourage research that identifies, distinguishes between and determines the value relevance of clusters of technical operating environments that regular appear across all organizations, that regularly appear only within certain types of organizations (e.g., within certain competitive, industry, institutional or cultural contexts), and that seldom appear.

The same questions just raised with technical operating environments apply as well with business operating environments. In addition, we advocate research that searches for consistent patterns between technical operating environments and business operating environments. In other words, do path dependencies exist requiring specific technical operating environments be fabricated in order to fabricate specific business operating environments?

Configuring Technical Operating Environments and Business Operating Environments

Organizations choose, more or less mindfully, to fabricate operating environments that vary with regard to their asset-specificity. Many acquired operating environments are commodity-like in that they can be applied with comparable effectiveness across very different contextual settings. Examples of such commodity-like operating environments are those providing communications services such as electronic mail or videoconferencing. Many other operating environments prove most effective only after being tailored to a specific setting such that provided capabilities are tightly aligned with this setting. Examples of operating environments likely to benefit from a high degree of customization are those providing customer relationship management or business intelligence business capabilities. Generally, we expect a greater extent of customization to occur with business operating environments than with technical operating environments.

Deciding the extent to which a fabricated operating environment is to be customized is important for at least two reasons. First, operating environments characterized by low asset-specificity are less expensive to acquire, configure, and install. Second, assuming that the initial decision to install a low asset-specific operating environment proved to be an acceptable decision, there is little need – and hence less associated cost – to reconfigure the operating environment as the nature of the contextual setting changes. Thus, it would seem desirable for organizations to fabricate low asset-specific operating environments wherever doing so does not compromise the effectiveness of engendered capabilities. Three important research questions arise: First, what are the attributes of engendered capabilities for which capability effectiveness is invariant of deployed settings? Second, what are the commonly-applied technical capabilities and business capabilities that possess these attributes favoring low asset-specific operating environments? Third, what are the commonly-installed technical operating environments and business operating environments that engender these low asset-specific capabilities?

Many operating environments, however, are likely to prove valuable only when tightly aligned with an organizational setting. Such operating environments, however, tend to be costly to acquire/develop/configure/install and tend to require substantial, costly reconfiguration when either the deployment setting or foundational technologies substantively change. It is argued from both organizational (Sambamurthy et al., 2003; Zhou and Wu, 2010) and technology (Gosain et al., 2004; Ross, 2003; Saraf et al., 2007) perspectives that the costs associated with deploying high asset-specific resource sets can be attenuated through embedding architectural flexibility allowing an ease of reconfiguration and of coordination. Four important research questions arise. What is the nature of the architectural flexibility to be embedded within high asset-specific operating environments? Is it inherently more costly to fabricate operating environments with higher architectural flexibility than operating environments with lower architectural flexibility? If so, are their technological or organizational mechanisms available to diminish these costs? Can embedding sufficient architectural flexibility within installed technical operating environments reduce the costliness of tightly aligning an installed business operating environment with a dynamic contextual setting in the absence of embedding a high level of architectural flexibility within the business operating environment?

'Operating Environment→Business Capability→Business Performance' Relationships

Considerable organizational investment has been and will continue to be invested in fabricating operating environments provisioning the business capabilities that achieve organization performance enabling, minimally, survival and, ideally, growth and profitability levels exceeding those of competitors. Conceptually, two categories of provisioned business capabilities can be defined (Benjamin et al., 1990): competitive necessity business capabilities required for economic survival, and competitive advantage business capabilities that promise to distinguish organizations in competitively important ways.

Three important research questions are offered regarding operating environments fabricated for provisioning competitive-necessity business capabilities. Are there some operating environments that are constructed in all organizations to provide a core set of competitive necessity capabilities? Do additional layers of such common competitive-necessity operating environments exist for specific industry and institutional contexts? And, to what extent can these commonly-installed, competitive-necessity operating environments be configured as low asset-specific resource sets?

Four research questions are offered regarding operating environments fabricated for provisioning competitive-advantage capabilities. Can distinct categories of competitive-advantage business capabilities be defined? Do consistent patterns exist in the nature of the operating environments observed to provision the competitive-advantage business capabilities within each of these categories? If so, how do these patterns differ across specific industry and institutional contexts? Finally, to what extent, if at all, can these consistently-observed competitive-advantage operating environments be configured with low asset-specificity?

IMPLICATIONS FOR PRACTICE

Justifying investments for enhancing or reengineering substantial portions of an organization's IT infrastructure is one of the more difficult IT management issues, given the cost of such investments and the indirect nature of the influence of such investments on an organization performance. We anticipate that the conceptualizations that we have introduced provide managers facing such challenges with the insights and argumentative structures necessary for building convincing business cases. More specifically, we encourage managers responsible for designing, building and evolving their organization's IT infrastructure to clearly describe and depict: the technical operating environments and business operating environments that are to be enhanced or newly created within an IT infrastructure; the role of technical assets, technical capabilities and business assets in fabricating these operating environments; the competitive-necessity and/or competitive advantage business capabilities being provisioned through IT infrastructure investment; and, the manner by which and the extent to which their organizations' performance will be improved through the investment.

The conceptualizations introduced also underscore an under-appreciated outcome associated with investments made to enhance, extend or reengineer aspects of organizations' IT infrastructures: the enhancement of an existing operating environments, the addition of a new operating environment, or newly-gained opportunities for enhancing or adding the collection of operating environments that comprise organizations' IT infrastructures. For example, organizations today often acquire and configure an enterprise system as a means of provisioning specific sets of technical capabilities and business capabilities. But, we conjecture that all too often little analysis is undertaken to understand the nature of the operating environments that comprise the enterprise system and, more importantly, how these newly acquired operating environments can be leveraged to (1) enhance or extend the organization's IT infrastructure and (2) provision additional new technical capabilities and new business capabilities. We anticipate that our ideas will enable managers facing the challenge of justifying an IT infrastructure investment to expand their views of the reach and range of a proposed IT investment, further enriching the business case developed in support of the investment.

CONCLUSION

In this essay, we have offered a new theoretical conceptualization of the value-adding role of IT infrastructure and applied it to synthesize extant research. In doing so, our work has extended two broad literatures – one focused on IT infrastructure and the other focused on the business value of IT. More specifically, our work (1) provides for a more finely-grained theoretical foundation, along with substantive research guidance, for scholars interested in studying the nature and implications of IT infrastructure and (2) provides a comprehensive nomological net, across three distinct IT activity domains, for scholars interested in examining the value relevance of IT. It is our sincere hope that future studies building on and extending our ideas will produce rich, robust insights regarding the nature of and value-adding role of IT infrastructure as well as of other forms of IT-enabled resource sets.

REFERENCES

Agarwal, R., and Sambamurthy, V. "Principles and Models for Organizing the IT Function," *MIS Quarterly Executive* (1:1) 2002, pp 1-16.

Ahituv, N., Hadass, M., and Neumann, S. "A Flexible Approach to Information System Development," *MIS Quarterly* (8:2) 1984, pp 69-78.

Aral, S., and Weill, P. "IT Assets, Organizational Capabilities, and Firm Performance: How Resource Allocations and Organizational Differences Explain Performance Variation," *Organization Science* (18:5) 2007, pp 763-780.

Armstrong, C.P., and Sambamurthy, V. "Information Technology Assimilation in Firms: The Influence of Senior Leadership and IT Infrastructures," *Information Systems Research* (10:4) 1999, pp 304-327.

Barney, J.B. "Firm Resources and Sustained competitive Advantage," *Journal of Management* (17:1) 1991, pp 99-120.

Barry, E.J., Kemerer, C.F., and Slaughter, S.A. "Environmental Volatility, Development Decision, and Software Volatility: A Longitudinal Analysis," *Management Science* (52:3) 2006, pp 448-464.

Barua, A., Kriebel, C.H., and Mukhopadhyay, T. "Information Technologies and Business Value: An Analytic and Empirical Investigation," *Information Systems Research* (6:1) 1995, pp 3-23.

Bendoly, E., Citurs, A., and Konsynski, B. "Internal Infrastructural Impacts on RFID Perceptions and Commitment: Knowledge, Operational Procedures, and Information Processing Standards," *Decision Sciences* (38:3) 2007, pp 423-449.

Benjamin, R.I., deLong, D.W., and Scott-Morton, M.S. “Electronic Data Interchange: How Much Competitive Advantage,” *Long Range Planning* (23:1) 1990, pp 29-40.

Benner, M.J., and Tushman, M.L. "Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited," *The Academy of Management Review* (28:2) 2003, pp 238-256.

Bersoff, E.H. "Elements of Software Configuration Management," *IEEE Transactions on Software Engineering* (10:1) 1984, pp 79-88.

Bharadwaj, A.S. "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly* (24:1) 2000, pp 169-196.

Bharadwaj, S., Bharadwaj, A., and Bendoly, E. "The Performance Effects of Complementarities Between Information Systems, Marketing, Manufacturing, and Supply Chain Processes," *Information Systems Research* (18:4) 2007, pp 437-453.

Bhatt, G.D., and Grover, V. "Types of Information Technology Capabilities and Their Role in Competitive Advantage: An Empirical Study," *Journal of Management Information Systems* (22:2) 2005, pp 253-278.

Broadbent, M., Weill, P., Clair, D.S., and Kearney, A.T. "The Implications of Information Technology Infrastructure for Business Process Redesign," *MIS Quarterly* (23:2) 1999, pp 159-182.
Brynjolfsson, E., and Hitt, L. "Paradox Lost? Firm-level Evidence on the Returns to Information Systems Spending," *Management Science* (42:4) 1996, pp 541-558.
Byrd, T.A., and Turner, D.E. "Measuring the Flexibility of Information Technology Infrastructure: Exploratory Analysis of a Construct," *Journal of Management Information Systems* (17:1) 2000, pp 167-208.
Chan, Y.E., Huff, S.L., Barclay, D.W., and Copeland, D.G. "Business Strategic Orientation, Information Systems Strategic Orientation, and Strategic Alignment," *Information Systems Research* (8:2) 1997, pp 125-150.
Chan, Y.E. "Why Haven't We Mastered Alignment? The Importance of the Informal Organization Structure," *MIS Quarterly Executive* (1:2) 2002, pp 97-112.
Chatterjee, D., Grewal, R., and Sambamurthy, V. "Shaping up for E-Commerce: Institutional Enablers of the Organizational Assimilation of Web Technologies," *MIS Quarterly* (26:2) 2002, pp 65-89.
Chiasson, M.W. and Davidson, E. "Taking Industry Seriously in Information Systems Reserch," *MIS Quarterly* (29:4) 2005, pp 591-605.
Clark, C.E., Cavanaugh, N.C., Brown, C.V., and Sambamurthy, V. "Building change-readiness capabilities in the IS organization: Insights from the Bell Atlantic," *MIS Quarterly* (21:4) 1997, pp 425-455.
Coff, R.W. "The Coevolution of Rent Appropriability and Capability Development," *Strategic Management Journal* (31:7) 2010, pp 711-733.
Dewan, S., and Min, C.-k. "The Substitution of Information Technology for Other Factors of Production: A Firm Level Analysis," *Management Science* (43:12) 1997, pp 1660-1675.
Dewan, S., Shi, C., and Gurbaxani, V. "Investigating the Risk Return Relationship of Information Technology Investment: Firm-Level Empirical Analysis," *Management Science* (53:12) 2007, pp 1829-1842.
Dixon, P.J., and John, D.A. "Technology Issues Facing Corporate Management in the 1990s," *MIS Quarterly* (13:3) 1989, pp 246-255.
Doll, W.J. "Avenues for Top Management Involvement in Successful MIS Development," *MIS Quarterly* (9:1) 1985, pp 17-35.
Dong, S., Xu, S.X., and Zhu, K.X. "Research Note--Information Technology in Supply Chains: The Value of IT-Enabled Resources Under Competition," *Information Systems Research* (20:1) 2009, pp 18-32.
Doty, D.H., Glick, W.H., and Huber, G.P. "Fit, Equifinality, and Organizational Effectiveness: A Test of Two Configurational Theories," *The Academy of Management Journal* (36:6) 1993, pp 1196-1250.
Drury, D.H. "An Evaluation of Data Processing Steering Committees," *MIS Quarterly* (8:4) 1984, pp 257-265.
Duncan, N.B. "Capturing Flexibility of Information Technology Infrastructure: A Study of Resource Characteristics and their Measure," *Journal of Management Information Systems* (12:2) 1995, pp 37-57.
Ethiraj, S.K., Kale, P., and Krishnan, M.S. "Where Do Capabilities Come from and How Do They Matter? A Study in the Software Services Industry," *Strategic Management Journal* (26:1) 2005, pp 25-45.

Farjoun, M. “Beyond Dualism: Stability and change as a Duality,” *Academy of Management Review* (35: 2) 2010, pp 202-225.
Fedorowicz, J., and Konsynski, B.R. "Organization Support Systems: Bridging Business and Decision Processes," *Journal of Management Information Systems* (8:4) 1992, pp 5-26.
Feeny, D.F., and Willcocks, L.P. "Core IS Capabilities for Exploiting Information Technology," *Sloan Management Review* (39:3) 1998, pp 9-21.
Fichman, R.G. “Real Options and IT Platform Adoption: Implications for Theory and Practice,” Information Systems Research (15:2) 2004, pp 132-154.
Ghosh, B., and Scott, J.E. "Relational Alignment in Offshore IS Outsourcing," *MIS Quarterly Executive* (8:1) 2009, pp 19-29.
Gosain, S., Malhotra, A., and El Sawy, O.A. "Coordinating for Flexibility in e-Business Supply Chains," *Journal of Management Information Systems* (21:3) 2004, pp 7-46.
Grant, R.M. "Toward a Knowledge-Based Theory of the Firm," *Strategic Management Journal* (17) 1996, pp 109-122.
Gupta, A.K., Smith, K.G., and Shalley, C.E. "The Interplay between Exploration and Exploitation," *Academy of Management Journal* (49:4) 2006, pp 693-706.
Gupta, Y.P., and Raghunathan, T.S. "Impact of Information Systems (IS) Steering Committees on IS Planning," *Decision Sciences* (20:4) 1989, pp 777-793.
Hall, W.A., and McCauley, R.E. "Planning and Managing a Corporate Network Utility," *MIS Quarterly* (11:4) 1987, pp 437-449.
Harter, D.E., Krishnan, M.S., and Slaughter, S.A. "Effects of Process Maturity on Quality, Cycle Time, and Effort in Software Product Development," *Management Science* (46:4) 2000, pp 451-466.
Hawk, S., Zheng, W., and Zmud, R.W. “Overcoming Knowledge-Transfer Barriers in Infrastructure Management Outsourcing: Lessons from a Case Study,” MISQ Executive (8:3) 2009, pp 89-105.
He, Z.-L., and Wong, P.-K. "Exploration vs. Exploitation: An Empirical Test of the Ambidexterity Hypothesis," *Organization Science* (15:4) 2004, pp 481-494.
Hitt, L.M., Wu, D.J., and Zhou, X. "Investment in Enterprise Resource Planning: Business Impact and Productivity Measures," *Journal of Management Information Systems* (19:1) 2002, pp 71-98.
Iyer, B. and Henderson, J.C. “Preparing for the Future: Understanding the Seven Capabilities of Cloud Computing,” *MIS Quarterly Executive* (9: 2) 2010, pp 117-131.
Johnson, M.W., Christensen, C.M., and Kagermann, H. “Reinventing Your Business Model,” *Harvard Business Review* 1999 (86:12), pp 57-68.
Jeffers, P.I., Muhanna, W.A., and Nault, B.R. "Information Technology and Process Performance: An Empirical Investigation of the Interaction Between IT and Non-IT Resources," *Decision Sciences* (39:4) 2008, pp 703-735.
Kane, G.C., and Alavi, M. "Information Technology and Organizational Learning: An Investigation of Exploration and Exploitation Processes," *Organization Science* (18:5) 2007, pp 796-812.
Kaplan, R.S., and Norton, D.P. "Putting the Balanced Scorecard to Work," Harvard *Business Review* (September-October) 1993, pp 134-147.
Kaplan, R.S., and Norton, D.P. "Using the Balanced Scorecard as a Strategic Management System," *Harvard Business Review* (January-February) 1996, pp 75-85.

Kaplan, R.S., and Norton, D.P. "The Balanced Scorecard: Measures that Drive Performance," *Harvard Business Review* (Judy-August) 2005, pp 172-180.
Karimi, J., Somers, T.M., and Bhattacherjee, A. "The Role of Information Systems Resources in ERP Capability Building and Business Process Outcomes," *Journal of Management Information Systems* (24:2) 2007, pp 221-260.
Kearns, G.S., and Lederer, A.L. "A Resource-Based View of Strategic IT Alignment: How Knowledge Sharing Creates Competitive Advantage," *Decision Sciences* (34:1) 2003, pp 1-29.
Kearns, G.S., and Sabherwal, R. "Strategic Alignment between Business and Information Technology: A Knowledge-Based View of Behaviors, Outcome, and Consequences," *Journal of Management Information Systems* (23:3) 2006/2007, pp 129-162.
Kearns, G.S., and Sabherwal, R. "Antecedents and Consequences of Information Systems Planning Integration," *IEEE Transactions on Engineering Management* (54:4) 2007, pp 628-643.
Kettinger, W.J., Marchand, D.A., and Davis, J.M. "Designing Enterprise IT Architectures to Optimize Flexibility and Standardization in Global Business," *MIS Quarterly Executive* (9: 2) 2010, pp 95-113.
Krishnan, M.S., Kriebel, C.H., Sunder, K., and Mukhopadhyay, T. "An Empirical Analysis of Productivity and Quality in Software Products," *Management Science* (46:6) 2000, pp 745-759.
Kumar, R.L. "A Framework for Assessing the Business Value of Information Technology Infrastructures," *Journal of Management Information Systems* (21:2) 2004, pp 11-32.
Lederer, A.L., and Mendelow, A.L. "Coordination of Information Systems Plans with Business Plans," *Journal of Management Information Systems* (6:2) 1989, pp 5-19.
Lind, M.R., and Zmud, R.W. "The Influence of a Convergence in Understanding between Technology Providers and Users on Information Technology Innovativeness," *Organization Science* (2:2) 1991, pp 195-217.
Liu, L., and Yetton, P. "The Contingent Effects on Project Performance of Conducting Project Reviews and Deploying Project Management Offices," *IEEE Transactions on Engineering Management* (54:4) 2007, pp 789-799.
Magretta, J. "The Power of Virtual Integration: An Interview with Dell Computer's Michael dell," Harvard Business Review (76:2) 1998, pp. 72-85.
Malhotra, A., Gosain, S., and El Sawy, O.A. "Leveraging Standard Electronic Business Interfaces to Enable Adaptive Supply Chain Partnerships," *Information Systems Research* (18:3) 2007, pp 260-279.
March, J.G. "Exploration and Exploitation in Organizational Learning," *Organization Science* (2:1) 1991, pp 71-87.
McDermott, C.M., and Marucheck, A. "Training in CAD: An Exploratory Study of Methods and Benefits," *IEEE Transactions on Engineering Management* (42:4) 1995, pp 410-418.
McGee, M.K. "IT Budgets Will Go up or Stay Flat for Most Companies in 2009," in: *InformationWeek*, 2008.
Melville, N., Kraemer, K., and Gurbaxani, V. "Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value," *MIS Quarterly* (28:2) 2004, pp 283-322.
Mitra, S. "Information Technology as an Enabler of Growth in Firms: An Empirical Assessment," *Journal of Management Information Systems* (22:2) 2005, pp 279-300.

Muller, S.D., Kraemmergaard, P., and Mathiassen, L. "Managing Cultural Variation in Software Process Improvement: A Comparison of Methods for Subculture Assessment," *IEEE Transactions on Engineering Management* (56:4) 2009, pp 584-599.

Mutch. A. "Technology, Organization, and Structure—A Morphogenetic Approach," *Organization Science* (21:2) 2010, pp 507-520.

Nelson, K.M., and Cooprider, J.G. "The Contribution of Shared Knowledge to IS Group Performance," *MIS Quarterly* (20:4) 1996, pp 409-432.

Nelson, P., Richmond, W. and Seidmann, A., "Two Dimensions of Software Acquisition," Communications of the ACM (39:7) 1996, pp. 29-35.

Nevo, S. and Wade, M.R., "The Formation and Value of IT-Enabled Resources: Antecedents and Consequences of Synergistic Relationships," *MIS Quarterly* (34:1) 2010, pp. 163-183.

Newkirk, H.E., and Lederer, A.L. "Incremental and Comprehensive Strategic Information Systems Planning in an Uncertain Environment," *IEEE Transactions on Engineering Management* (53:3) 2006, pp 380-394.

Nidumolu, S.R., and Subramani, M. "The Matrix of Control: Combining Process and Structure Approaches to Managing Software Development," *Journal of Management Information Systems* (20:3) 2003/2004, pp 159-196.

Oh, W., and Pinsonneault, A. "On the Assessment of the Strategic Value of Information Technologies: Conceptual and Analytical Approaches," *MIS Quarterly* (31:2) 2007, pp 239-265.

Parthasarthy, R., and Sethi, S.P. "Relating Strategy and Structure to Flexible Automation: A Test of Fit and Performance Implications," *Strategic Management Journal* (14:7) 1993, pp 529-550.

Patnayakuni, R., Rai, A., and Tiwana, A. "Systems Development Process Improvement: A Knowledge Integration Perspective," *IEEE Transactions on Engineering Management* (54:2) 2007, pp 286-300.

Pavlou, P.A., and El Sawy, O.A. "From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development," *Information Systems Research* (17:3) 2006, pp 198-227.

Piccoli, G., and Ives, B. "Review: IT-Dependent Strategic Initiatives and Sustained Competitive Advantage: A Review and Synthesis of the Literature," *MIS Quarterly* (29:4) 2005, pp 747-776.

Powell, T.C., and Dent-Micallef, A. "Information Technology as Competitive Advantage: The Role of Human, Business, and Technology Resources," *Strategic Management Journal* (18:5) 1997, pp 375-405.

Preston, D.S., and Karahanna, E. "Antecedents of IS Strategic Alignment: A Nomological Network," *Information Systems Research* (20:2) 2009, pp 159-179.

Purvis, R.L., Sambamurthy, V., and Zmud, R.W. "The Assimilation of Knowledge Platforms in Organizations: An Empirical Investigation," *Organization Science* (12:2) 2001, pp 117-135.

Rackoff, N., Wiseman, C., and Ullrich, W.A. "Information Systems for Competitive Advantage: Implementation of a Planning Process," *MIS Quarterly* (9:4) 1985, pp 285-294.

Rai, A. and Tang, X. "Leveraging IT Capabilities and Competitive Process Capabilities for the Management of Interorganizational Relationship Portfolios," *Information Systems Research* (21:3) 2010, pp 516-542.

Rai, A., Patnayakuni, R., and Seth, N. "Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities," *MIS Quarterly* (30:2) 2006, pp 225-246.

Ramasubbu, N., Mithas, S., Krishnan, M.S., and Kemerer, C.F. "Work Dispersion, Process-Based Learning and Offshore Software Development Performance," *MIS Quarterly* (32:2) 2008, pp. 437-458
Ranganathan, C., and Brown, C.V. "ERP Investments and the Market Value of Firms: Toward an Understanding of Influential ERP Project Variables," *Information Systems Research* (17:2) 2006, pp 145-161.
Ranganathan, C., and Sethi, V. "Rationality in Strategic Information Technology Decisions: The Impact of Shared Domain Knowledge and IT Unit Structure," *Decision Sciences* (33:1) 2002, pp 59-86.
Rathwell, M.A., and Burns, A. "Information Systems Support for Group Planning and Decision-Making Activities," *MIS Quarterly* (9:3) 1985, pp 255-271.
Ravichandran, T., and Lertwongsatien, C. "Effect of Information Systems Resources and Capabilities on Firm Performance: A Resource-Based Perspective," *Journal of Management Information Systems* (21:4) 2005, pp 237-276.
Ravichandran, T., and Rai, A. "Quality Management in Systems Development: An Organizational System Perspective," *MIS Quarterly* (24:3) 2000, pp 381-415.
Ray, G., Muhanna, W.A., and Barney, J.B. "Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis," *MIS Quarterly* (29:4) 2005, pp 625-651.
Ross, J.W., "Creating a Strategic IT Architecture Competence: Learning in Stages," *MIS Quarterly Executive* (2:1) 2003, pp 31-43.
Ross, J.W., Beath, C.M., and Goodhue, D.L. "Develop Long-Term Competitiveness through IT Assets," *Sloan Management Review* (38:1) 1996, pp 31-42.
Ross, J.W., Weill, P., and Robertson, D.C. *Enterprise Architecture as Strategy*. Harvard Business School, Boston, Massachusetts, 2006.
Rowen, R.B. "Software Project Management Under Incomplete and Ambiguous Specifications," *IEEE Transactions on Engineering Management* (37:1) 1990, pp 10-21.
Rumelt, R.P. "Theory, Strategy, and Entrepreneurship," in: *The Competitive Challenge: Strategies for Industrial Innovation and Renewal*, D.J. Teece (ed.), Ballinger, Cambridge, Mass, 1987, pp. 137-158.
Sabherwal, R. "The Relationship Between Information System Planning Sophistication and Information System Success: An Empirical Assessment," *Decision Sciences* (30:1) 1999, pp 137-167.
Sabberwal, R., and Chan, Y.E. "Alignment between Business and IS Strategies: A Study of Prospectors, Analyzers, and Defenders," *Information Systems Research* (12:1) 2001, pp 11-33.
Sabberwal, R., and Kirs, P. "The Alignment Between Organizational Critical Success Factors and Information Technology Capability in Academic Institutions," *Decision Sciences* (25:2) 1994, pp 301-330.
Sambamurthy, V., Bharadwaj, A., and Grover, V. "Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms," *MIS Quarterly* (27:2) 2003, pp 237-263.
Sambamurthy, V., and Zmud, R.W. "Research Commentary: The Organizing Logic for an Enterprise's IT Activities in the Digital Era--A Prognosis of Practice and a Call for Research," *Information Systems Research* (11:2) 2000, pp 105-114.

Saraf, N., Langdon, C.S., and Gosain, S. "IS Application Capabilities and Relational Value in Interfirm Partnerships," *Information Systems Research* (18:3) 2007, pp 320-339.

Schilling, M.A., and Phelps, C.C. "Interfirm Collaboration Networks: The Impact of Large-Scale Network Structure on Firm Innovation," *Management Science* (53:7) 2007, pp 1113-1126.

Segars, A.H., and Grover, V. "Profiles of Strategic Information Systems Planning," *Information Systems Research* (10:3) 1999, pp 199-232.

Segars, A.H., Grover, V., and Teng, J.T.C. "Strategic Information Systems Planning: Planning System Dimensions, Internal Coalignment, and Implications for Planning Effectiveness," *Decision Sciences* (29:2) 1998, pp 303-345.

Simon, H.A. *The New Science of Management Decision*. Upper Saddle River, NJ: Prentice Hall PTR, 1977.

Sircar, S., Turnbow, J.L., and Bordoloi, B. "A Framework for Assessing the Relationship Between Information Technology Investments and Firm Performance," *Journal of Management Information Systems* (16:4) 2000, pp 69-98.

Slaughter, S.A., and Kirsch, L.J. "The Effectiveness of Knowledge Transfer Portfolios in Software Process Improvement: A Field Study," *Information Systems Research* (17:3) 2006, pp 301-320.

Soh, C. and Sia, S.K. “The Challenge of Implementing ‘Vanilla’ Versions of Enterprise Systems,” MIS Quarterly Executive (4:3) 2005, pp. 373-384.

Star, S.L., and Ruhleder, K. "Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research* (7:1) 1996, pp 111-134.

Taylor, A., and Helfat, C.E. "Organizational Linkages for Surviving Technological Change: Complementary Assets, Middle Management, and Ambidexterity," *Organization Science* (20:4) 2009, pp 718-739.

Teece, D.J. "Explicating Dynamic Capabilities: The Nature and Microfoundations of (Sustainable) Enterprise Performance," *Strategic Management Journal* (28:13) 2007, pp 1319-1350.

Tuckman, B.W. "Developmental Sequence in Small Groups," *Psychological Bulletin* (63:6) 1965, pp 384-399.

Uotila, J., Maula, M., Keil, T., and Zahra, S. "Exploration, Exploitation, and Financial Performance: Analysis of S&P 500 Corporations," *Strategic Management Journal* (30:2) 2009, pp 221-231.

U.S. Census Bureau "Business Spending on Information and Communication Technology Infrastructure Reaches $264 Billion in 2007," 2009.

van de Ven, A.H. "Central Problems in the Management of Innovation," *Management Science* (32:5) 1986, pp 590-607.

Venkatraman, N. "Five Steps to a Dot-Com Strategy: How to Find Your footing on the Web," *Sloan Management Review* (41:3) 2000, pp 15-28.

Wade, M., and Hulland, J. "Review: The Resource-Based View and Information Systems Research: Review, Extension, and Suggestions for Future Research," *MIS Quarterly* (28:1) 2004, pp 107-142.

Ward, P., and Zhou, H. "Impact of Information Technology Integration and Lean/Just-In-Time Practices on Lead-Time Performance," *Decision Sciences* (37:2) 2006, pp 177-203.

Weill, P., and Aral, S. "Generating Premium Returns on Your IT Investments," *Sloan Management Review* (47:2) 2006, pp 39-48.

Weill, P., and Broadbent, M. *Leverage the New Infrastructure: How Market Leaders Capitalize on Information Technology*. Harvard Business School Press, Boston, Massachusetts, 1998.

Xia, W., and Lee, G. "Complexityof Information Systems Development Projects: Conceptualization and Measurement Development," *Journal of Management Information Systems* (22:1) 2005, pp 45-84.

Xu, P., and Ramesh, B. "Software Process Tailoring: An Empirical Investigation," *Journal of Management Information Systems* (24:2) 2007, pp 293-328.

Zhou, K.Z., and Wu. F. "Technological Capability, Strategic Flexibility and Product Innovation," Strategic Management Journal, 31(5) 2010, pp 547-561.

Zhu, K. "The Complementarity of Information Technology Infrastructure and E-Commerce Capability: A Resource-Based Assessment of Their Business Value," *Journal of Management Information Systems* (21:1) 2004, pp 167-202.

Zhu, K., and Kraemer, K.L. "E-Commerce Metrics for Net-Enhanced Organizations: Assessing the Value of E-Commerce to Firm Performance in the Manufacturing Sector," *Information Systems Research* (13:3) 2002, pp 275-295.

Zmud, R.W. "Design Alternatives for Organizing Information Systems Activities," MIS *Quarterly* (8:2) 1984, pp 79-93.

Zmud, R.W., Boynton, A.C., and Jacobs, G.C. "The Information Economy: A New Perspective for Effective Information Systems Management," *ACM SIGMIS Database* (18:1) 1986, pp 17-23.

Table 1. The Nature of IT Infrastructure [a]	
Definition	**Source**
IT infrastructure generally describes a set of *shared*, tangible, IT resources that provide a *foundation* to enable present and future business applications. The primary, tangible resources include: 1. "Platform technology" (i.e., hardware and operating systems); 2. Network and telecommunication technologies; 3. Key data; and 4. Core data-processing applications.	Duncan, 1995
An infrastructure occurs when the tension between local and global is resolved. That is, an infrastructure occurs *when local practices are afforded by a larger-scale technology*, which can then be used in a natural, ready-to-hand fashion.	Star & Ruhleder, 1996
The *foundation* of the information technology portfolio is the firm's *long-term* information technology infrastructure. It must be *managed by a partnership of business and technical management* to create business value.	Weill & Broadbent, 1998
IT infrastructure is defined as the base *foundation* of the IT portfolio (including both technical and human assets), *shared* throughout the firm in the form of reliable services, and *usually coordinated by the IS group*.	Broadbent et al., 1999
IT infrastructures refer to the *shared* IT resource base (or an IT platform) that *supports* the development of different business applications.	Chatterjee et al., 2002
IT infrastructure represents a firm's technology platform and information *foundation* from which enterprise applications emanate, and it is normally conceived to include hardware, software, networks, and data processing architecture.	Zhu, 2004
IT infrastructure is defined as a *shared* set of capital resources that provide the *foundation* on which specific IT applications are built. The primary constituents of IT infrastructure are (1) computing platform (hardware and operating systems), (2) communications network, (3) critical shared data, and (4) core data processing applications.	Ray et al. 2005
IT infrastructure provides the *foundation* of *shared* IT services (both technical and human—e.g., servers, networks, laptops, shared customer databases, help desk, application development) used by multiple IT applications	Aral & Weill, 2007
Infrastructure resources refer to a firm's *shared* IT assets (e.g., hardware, software tools, networks, databases, and data centers).	Karimi et al., 2007

[a] Italics added by authors.

Table 2: Components of IT Infrastructure [b]	
Definition	**Source**
IT infrastructure generally describes a set of shared, tangible, IT resources that provide a foundation to enable present and future business applications. The primary, tangible resources include: *hardware and operating systems, network and telecommunication technologies, key data, and core data processing applications*.	Duncan, 1995
IT infrastructure consists of three key IT assets: (1) a highly competent IT *human* resource, (2) a reusable *technology* base, and (3) a strong *partnering relationship* between IT and business management	Ross et al., 1996
IT infrastructures include *platform technologies* (hardware and operating systems), *network and telecommunications technologies*, and *databases* and *a variety of shared services*, such as EDI, e-mail, universal file access, and videoconferencing and teleconferencing services.	Armstrong & Sambamurthy, 1999
IT infrastructure is defined as the base foundation of the IT portfolio (including both *technical* and *human assets*), shared throughout the firm in the form of reliable services, and usually coordinated by the IS group.	Broadbent et al., 1999
The physical IT assets which form the core of a firm's overall IT infrastructure comprise the *computer and communication technologies and the shareable technical platforms and databases*	Bharadwaj, 2000
IT infrastructure can be separated into a *technical IT infrastructure and a human IT infrastructure*. The technical infrastructure pertains to applications, data and technology configurations. The human infrastructure pertains to the knowledge and capabilities required to manage effectively the IT resources within the organization.	Byrd & Turner, 2000
An information technology infrastructure is a collection of *technologies, people, and processes* that facilitates large-scale connectivity and effective interoperation of an organization's IT applications. The technology component of an effective IT infrastructure includes technologies for effective data storage and retrieval (e.g., storage area networks), system integration (e.g., middleware), connectivity (e.g., networking components), and security technologies (e.g., firewalls). The people component includes infrastructure architects and other employees charged with infrastructure design and support. The process component includes processes for architecture standardization and infrastructure change reviews.	Kumar, 2004
IT infrastructure represents a firm's technology platform and information foundation from which enterprise applications emanate, and it is normally conceived to include *hardware, software, networks, and data processing architecture*.	Zhu, 2004
IT infrastructure is defined as a shared set of capital resources that provide the foundation on which specific IT applications are built. The primary constituents of IT infrastructure are: *hardware and operating systems, communications network, critical shared data and core data processing applications*.	Ray et al. 2005
IT infrastructure provides the foundation of shared IT services (both *technical and human*, e.g., servers, networks, laptops, shared customer databases, help desk, application development) used by multiple IT applications	Aral & Weill, 2007
Infrastructure resources refer to a firm's shared IT assets (e.g., *hardware, software tools, networks, databases, and data centers*).	Karimi et al., 2007

[b] Italics added by authors.

Table 3: RBV-based Research on the Business Value of IT Infrastructure

Asset Type	***Study***	***Main Findings***
Physical	**Barua et al., 1995**	• IT capital has a positive impact on production capacity utilization, inventory turnover, and a negative effect on inferior quality and relative price, which in turn affect ROA and market share of firms.
	Brynjolfsson & Hitt, 1996	• Computer capital (i.e., market value of central processors, PCs and terminals) is associated with increased output (i.e., normalized total sales).
	Dewan & Min, 1997	• IT capital (i.e., the sum of IS labor expenses, market value of central processors and the total value of desktop machines) produces excessive returns (annual value added for the firm) relative to labor.
	Sircar et al., 2000	• Investments in physical assets such as PCs and terminals are associated with enhanced firm performance (e.g., sales, assets, market share, equity, shares and net income) in all sectors except retail sales.
	Chatterjee et al., 2002	• Announcements of IT infrastructure investments are associated with significant abnormal returns and significant increase in trading volume.
	Zhu & Kraemer, 2002	• Investment in physical assets (e.g., PCs and LANs) per employee is associated with decreased cost of goods sold for high-tech firms but increased cost of goods sold for traditional manufacturing firms.
	Zhu, 2004	• Investment in physical assets (e.g., mainframes, mini-systems, PCs, and LANs) has a positive effect on sales and on inventory turnover.
	Mitra, 2005	• IT infrastructure (e.g., servers, mainframes, telecommunication networks) investments can lower the total cost of operations for high-growth firms.
	Dewan et al., 2007	• Investments in IT physical assets (mainframe CPUs, peripheral devices, minicomputers, PCs) account for a significant portion of overall firm risk, significantly greater than that associated with non-IT capital. • The higher the risk, the higher the return on investments in IT physical assets. • IT risk is positively associated with firm value, and incorporation of IT risk reduces the positive influence of investments in IT physical assets on firm value.
Data & Technical Capabilities	**Hitt et al., 2002**	• ERP adopters evidenced greater performance in terms of sales per employee, profit margin, ROA, inventory turnover, asset utilization, AR turnover, higher productivity and higher market value (Tobin's *q*).
	Ranganathan & Brown, 2006	• ERP adopters evidenced higher cumulative abnormal returns, an effect amplified by greater ERP functional scope and physical scope
	Karimi et al., 2007	• Greater availability of infrastructure assets leads to greater ERP (functional, organizational, and geographic) scope • Greater ERP scope leads to increased operations efficiency, effectiveness, and flexibility.
Human	**Brynjolfsson & Hitt, 1996**	• IT labor capital is associated with increased output (i.e., normalized total sales).
	Sircar et al., 2000	• IT staff training and IT staff budget are associated with enhanced firm performance in terms of sales, assets, market share, equity, shares and net income.
Relational	**Bhatt & Grover, 2005**	• The relationship between IT groups and line management is positively associated with relative firm performance (e.g., financial performance, sales growth, and profitability) with respect to the competitors

Table 4: IT Infrastructure Research in the Solution Identification Domain

Study	*IT Infrastructure Assets*	*Operating Environments*	*Business Capabilities*	*Organization Performance*	*Contingency Factors*	*Main Findings*
Drury (1984)	• Human • Administrative	Business • Managerial interaction	• IT strategic planning			• Use of steering committee composed of business managers, users, and IS personnel can improve strategic planning capability in terms of top management involvement in the planning process, user participation in the planning process, IS personnel's awareness of user needs, and IS managers' perceived effectiveness of long range IS planning.
Gupta & Raghunathan (1989)	• Human • Administrative	Business • Managerial interaction	• IT strategic planning		Moderation • Industry	• Use of steering committee composed of business managers and IS personnel can improve strategic planning capability in terms of top management involvement in the planning process, hardware integration, achievement of planning goals, and coordination of IS planning effort. • This impact of steering committee is more salient in mining, wholesale trade, and financial institutions than in manufacturing and construction industries.
Lederer & Mendelow (1989)	• Human • Administrative	Business • Managerial interaction	• IT strategic planning			• Participation of business and IS managers in the planning process and IS managers' reliance on business management's planning process are conductive to the coordination of IS plans with business plans.
Segars et al. 1998)	• Human • Administrative	Business • Managerial interaction	• IT strategic planning			• The alignment among the different elements of a planning process (i.e., comprehensiveness, formalization, focus, flow, participation of managers from different functional areas, and consistency) is associated with greater IT strategic planning capability in terms of top IS managers' perceived planning effectiveness (i.e., contributing to the financial performance of the firm, enabling better managerial decisions, ability to identify new IT-based opportunities before competitors, justifiable investments of time, money, and effort, providing valuable input to top management, generating new and novel ideas, and plans being implemented).
Sabherwal (1999)	• Administrative • Technical capabilities	Business • Managerial interaction	• IT strategic planning	Perceptual • Exploitative		• Integrative mechanisms, such as steering committees and task forces, and greater technical capability can improve IT strategic planning capability in terms of the formalization of the planning process, alignment between the planning process and business plans, involvement of top management in the planning process, IS managers' business knowledge, and top management's IT knowledge. • Greater IT strategic planning capability has a positive impact on organizational performance outcomes including: deploying IT in distinguishing an organization from similar organizations, reducing administrative costs, improving the efficiency of internal operations, and enhancing organizational reputation.
Segars & Grover (1999)	• Human • Administrative	Business • Managerial interaction	• IT strategic planning			• A planning process emphasizing comprehensiveness, formalization, integration, top-down planning flow, broad participation of IS and business managers, and high consistency is likely to produce greater strategic planning capability in terms of alignment between IS and business strategies, IT planners' understanding of the internal operations of an organization, cooperation among stakeholders of a planning process, and improvement in the strategic planning capability.

Table 4: IT Infrastructure Research in the Solution Identification Domain (continued)						
Study	***IT Infrastructure Assets***	***Operating Environments***	***Business Capabilities***	***Organization Performance***	***Contingency Factors***	***Main Findings***
Ranganathan & Sethi (2002)	• **Human** • **Relational** • **Administrative**	**Business** • **Managerial interaction**	• **IT strategic planning**			• **The manner by which responsibilities for IT activities are assigned affects the extent to which domain knowledge is shared between business managers and IS managers.** • **The manner by which responsibilities for IT activities are assigned affects the rationality of the IT planning process (extent of information search, reliance on internal or external information sources, extent of information analysis, adoption of analytical techniques, identification of alternatives, and explicit evaluation criteria).** • **Shared domain knowledge positively impacts the rationality of the IT planning process.**
Kearns & Lederer (2003)	• **Human** • **Administrative**	**Business** • **Managerial interaction**	• **IT strategic planning**	**Perceptual** • **Exploitative**	**Antecedent** • **Information intensity**	• **Information intensity in business operations is positively related to CIO participation in business planning and CEO participation in IT planning.** • **Greater CIO participation in business planning and greater CEO participation in IT planning are positively associated with greater IT strategic planning capability (aligned with business plan) and greater business strategic planning capability (aligned with IT plan).** • **Greater IT strategic planning capability is positively associated with a greater observance of IT-enabled competitive advantage (lower product costs, product differentiation, increased customers switching costs, electronic links with business partners, and the creation of market entry barriers).**
Newkirk & Lederer (2006)	• **Human** • **Administrative**	**Business** • **Managerial interaction**	• **IT strategic planning**		**Moderation** • **Environment uncertainty**	• **Greater comprehensiveness (formal analysis, review processes, consideration of business plans, broad participation of IS and business personnel) of the planning process leads to greater strategic planning capability (aligned IS and business strategies, better understanding of IT planners of the organization's internal operations, better cooperation among stakeholders).** • **The positive impact of planning process comprehensiveness is stronger in more stable and more predictable business environments.**
Kearns & Sabherwal (2006/2007, 2007)	• **Human** • **Relational**	**Business** • **Managerial interaction**	• **IT strategic planning**	**Perceptual** • **Exploitative** • **Exploratory**	**Antecedent** • **Product-market diversity** • **Top manager's IT knowledge** • **Centralized IT governance**	• **Product-market diversity, top managers' IT knowledge and centralized IT governance are positively associated with business managers' participation in IT planning and IS managers' participation in business planning.** • **Business managers' participation in IT planning and IS managers' participation in business planning lead to greater strategic planning capability (top management's knowledge of IT and higher quality IT plans).** • **Greater top management IT knowledge is associated with fewer IT project implementation problems.** • **Greater strategic planning capability (quality of IT plans) and fewer IT project implementation problems lead to greater organization performance (market share, sales revenues, deployment of unique and inimitable systems).**
Preston & Karahanna, 2009	• **Human** • **Relational** • **Administrative**	**Business** • **Managerial interaction**	• **IT strategic planning** • **Business strategic planning**			• **CIO's formal involvement with Top Management Team (TMY) , CIO orchestration of IT-related events with TMT, and CIO/TMT experiential similarity enhance TMT IT knowledge.** • **Greater CIO business knowledge and greater TMT IT knowledge lead to a shared understanding regarding the role of IT within the organization** • **Greater shared understanding regarding the role of IT within the organization leads to greater alignment of IT strategies and business strategies**

Table 5: IT Infrastructure Research in the Solution Delivery Domain

Study	*IT Infrastructure Assets*	*Operating Environments*	*Business Capabilities*	*Organization Performance*	*Contingency Factors*	*Main Findings*
Doll, 1985	• **Human** • **Administrative**	**Technical** • **IT project management** • **Software development** • **IT portfolio Management**	• **Business solution development**			• **Top-management guidance into the policies, procedures, and decisions regarding IT project management, IT portfolio management, and software development improve a firm's capability to develop business solutions that are adaptable to business changes and are maintained at lower costs**
Ravichandran & Rai, 2000	• **Human** • **Administrative**	**Technical** • **IT quality management** • **Software development**	• **Business solution development**			• **IS top management leadership in quality management enhances quality-focused management infrastructure for software development** • **Greater quality-focused management infrastructure for software development leads to enhanced software development process management** • **Greater stakeholder participation leads to enhanced software development process management** • **Enhanced software development process management leads to better software development processes and products**
Nidumolu & Subramani, 2003/2004	• **Administrative**	**Technical** • **IT project management**	• **New (IT) product development**	**Perceptual** • **Exploitative** • **Exploratory**		• **Standardization of project performance criteria and decentralization of project development methods lead to more flexible and more predictable new product development processes.** • **More flexible and more predictable new product development processes lead to reduced product costs and increased market responsiveness.**
Liu & Yetton, 2007	• **Administrative**	**Technical** • **IT project management**	• **Business solution development**		**Moderation** • **Task uncertainty**	• **Greater use of project management offices and of project reviews leads to improved software development outcomes (schedule, cost, quality, and client satisfaction).** • **The positive effect of project management offices is stronger in high task uncertainty environments.** • **The positive effect of project reviews is stronger in low task uncertainty environments.**
Patnayakuni et al., 2007	• **Relational** • **Administrative**	**Technical** • **IT Project knowledge management**	• **Business solution development**			• **The greater the integrativeness of project governance practices and the broader the communication practices of development staff, the more enhanced is the IT project knowledge management environment** • **More enhanced IT project knowledge management environments lead to improved software development process and product performance**

Table 6: IT Infrastructure Research in the Solution Execution Domain

Study	*IT Infrastructure Assets*	*Operating Environments*	*Business Capabilities*	*Organization Performance*	*Contingency Factors*	*Main Findings*
Gosain et al., 2004	• Data • Design • Technical capabilities	Business • Integrated business processes • Enterprise data	• Offering flexibility • Partnering flexibility • Partner information sharing			• Process modularity leads to greater offering/partner flexibility • Data standardization leads to greater offering/partner flexibility • Quality of partner information sharing leads to greater offering/partner flexibility • Breadth of partner information sharing leads to less offering/partner flexibility
Zhu, 2004	• Physical		• E-commerce	Objective • Exploitative		• Greater investment in physical assets, in e-commerce capability and in both leads to greater sales per employee, lower COGS per employee and greater inventory turnover. • Greater investment in physical assets leads to lower ROA • Greater joint investment in physical assets and e-commerce capability leads to greater ROA
Ravichandran & Lertwongsatien, 2005	• Data • Human • Physical • Relational • Administrative • Technical capabilities	Business • Customer analysis & support • New product development		Perceptual • Exploitative		• Greater IT infrastructure investment leads to more enhanced IT-enabled environments for customer analysis/support & new product development • More enhanced IT-enabled environments for customer analysis/support & new product development leads to greater ROS and ROA
Rai et al., 2006	• Data • Technical capabilities	Business • Integrated business processes • Enterprise data	• Supply chain operations	Perceptual • Exploitative		• Operating environments characterized by cross-functional application integration and data consistency evidenced greater supply chain process integration • Greater supply chain process integration leads to improved operational performance and improved revenue growth.
Ward & Zhou, 2006	• Technical capabilities	Business • Integrated business processes	• Lean/JIT manufacturing	Perceptual • Exploitative		• Greater within-firm and between-firm integration of manufacturing/logistic processes leads to greater deployment of lean/JIT manufacturing practices • Greater deployment of lean/JIT manufacturing practices leads to decreased customer lead times.
Pavlou & El Sawy, 2006	• Technical capabilities	Business • Project & Resource Management • Knowledge Management • Cooperative work systems	• New product development	Perceptual • Exploitative • Exploratory	Moderation • Environ-mental turbulence	• Effective use of Project and Resource Management Systems, Knowledge Management Systems, and Cooperative Work Systems leads to greater new product development capabilities. • Greater new product development capabilities leads to increased new product development product effectiveness/process efficiency • Environmental turbulence enhances the benefit of the operating environments while weakening the impact of the business capabilities.

Table 6: IT Infrastructure Research in the Solution Execution Domain (continued)						
Study	***IT Infrastructure Assets***	***Operating Environments***	***Business Capabilities***	***Organization Performance***	***Contingency Factors***	***Main Findings***
Bharadwaj et al., 2007	• Data • Relational • Technical capabilities	Business • Enterprise data	• Manufacturing & marketing coordination • Manufacturing & supply chain coordination	Objective • Exploitative		• Greater coordination between IT staff and manufacturing staff leads to enhanced integrated access to relevant data • Greater integrated access to data, greater manufacturing and marketing coordination and greater manufacturing and supply chain coordination lead to improved manufacturing performance (inventory turns, product availability, operating margin) • The relationships between manufacturing performance and both manufacturing and marketing coordination and manufacturing and supply chain coordination are greater with heightened integrated access to relevant data
Malhotra et al., 2007	• Data • Design	Technical • Inter-organizational data flows	• Partner mutual adaptation • Partner mutual knowledge creation			• The use of standard electronic business interfaces improved both digitized, inter-organizational data flows and mutual adaptation with strategic partners • Enhanced digitized, inter-organizational data flows leads to greater mutual adaptation with strategic partners and to greater knowledge creation with strategic partners.
Jeffers et al., 2008	• Human	Business • Managerial interaction	• Customer Service	Perceptual • Exploitative		• Greater shared knowledge by IT managers and business managers regarding role of IT in enhancing customer service leads to improved customer service performance and firm financial performance
Dong et al., 2009	• Data • Human • Technical capabilities	Technical • Intra- and inter-organizational data flows Business • Supplier business process integration	• Supply chain operations	Perceptual • Exploitative	Moderation • Environmental Competitiveness	• Greater digitized, intra- and inter-organizational data flows lead to improved supply chain performance. • Greater supply chain performance leads to improvements in firm's competitive position. • Environmental competitiveness reinforces the benefit of the operating environment while weakening the impact of supply chain performance.
Rai & Tang, 2010	• Data • Design • Technical capabilities	Business • Supplier process alignment • Business platform reconfiguration Technical • Inter-organizational data integration • Technical platform reconfiguration	• Offering flexibility • Partnering flexibility	Perceptual • Exploitative	Moderation • Environmental turbulence • Supplier concentration	• Inter-organizational data integration and technical/business platform reconfiguration capabilities jointly enhance supplier process alignment and offering/partnering flexibility. • Supplier concentration weakens the positive impacts of inter-organizational data integration on offering/partnering flexibility but strengthens the positive impacts of business/technical platform reconfiguration on both supplier process alignment and offering/partnering flexibility. • Supplier process alignment interacts with offering/partnering flexibility to enhance competitive performance. • The influence of process alignment interacting with offering/partner flexibility in enhancing competitive performance is amplified when environment turbulence is high.