ORGANIZATIONAL AGILITY AND COMPLEX ENTERPRISE SYSTEM INNOVATIONS: A MIXED METHODS STUDY OF THE EFFECTS OF ENTERPRISE SYSTEMS ON ORGANIZATIONAL AGILITY

by

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DEDICATION

To my family and my teachers

Life would be a void

Without the purpose and direction that you provide
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Organizational Agility and Complex Enterprise System Innovations: A Mixed Methods Study of the Effects of Enterprise Systems on Organizational Agility

Abstract

by

AMOL T. KHARABE

Over the last two decades, firms have operated in increasingly accelerated ‘high-velocity’ dynamic markets, which require them to become agile. During the same time frame, firms have increasingly deployed complex enterprise systems - large-scale packaged software innovations that integrate and automate enterprise-wide organizational processes. While supporting efficiency, literature is divided on whether such innovations promote or hinder organizational agility. Relatively little is known about the effects of enterprise systems on organizational agility along the dimensions of organizational impact, organizational processes and organizational knowledge. These dimensions form the basis for the research in this dissertation: 1) What is the organizational impact of enterprise systems on agility i.e. do enterprise systems promote or hinder agility? 2) What are the organizational processes by which organizations reconcile with enterprise systems’ changing business needs driven by organizational agility? 3) What are the effects of organizational knowledge and competencies on the impact of enterprise systems on organizational agility?
To address these research questions the dissertation adopts a mixed methods approach. Part 1 proposes a theoretical framework based on innovation assimilation and dynamic capabilities and utilizes a quantitative approach to empirically validate the framework, by measuring the impact of enterprise systems on organizational agility, the effects of systems agility on organizational agility, as well as how systems agility influences enterprise systems’ impact on organizational agility. Part 2 employs a qualitative approach to examine a) how organizations reconcile with enterprise systems’ changing business needs driven by agility, as well as b) the outcomes of such reconciliation processes. Part 3 uses a quantitative approach to more deeply delve into the critical role of two organizational competencies - business competence in IT (BCIT) and IT competence in business (ITCB) - as antecedents to systems agility, as well as their moderating effect on the impact of enterprise systems on organizational agility.

The findings validate a) higher assimilation levels of enterprise systems positively influence organizational agility; b) systems agility acts as a powerful and critical enabler by amplifying the positive impact of enterprise systems assimilation on organization agility, in addition to having a strong direct effect. The paradox of enterprise systems promoting as well as hindering organizational agility can be explained by not controlling for assimilation levels or levels of systems agility. The reconciliation processes between changing business needs and enterprise systems indicates that in addition to economic and competitive forces the system itself is paradoxically a driver of change. The resultant cross-boundary teaming processes between business and IT in response to the changes can be a source of complexity and systemic risk. Finally, systems agility fully mediates the positive influence of ITCB on organizational agility and partially mediates the
positive influence of BCIT on organizational agility. In addition, ITCB has a negative moderating effect on the influence of enterprise systems’ assimilation on organizational agility.

In addition to supporting the view that organizations can achieve dexterity in both efficiency and agility through enterprise systems, the findings also promote an overall multi-level enterprise innovation view in which enterprise systems function as core system innovations which enable the rapid replication of local process innovations, resulting in increased overall organizational agility.

Key words: Organizational agility, enterprise systems, ERP, innovation assimilation, dynamic capabilities, systems agility, business competence in IT, IT competence in business
CHAPTER 1 – INTRODUCTION

Research Problem

Since the early 1990s, it has been clear that firms have been under two inexorable and transformational forces. First, firms in almost all industries have been operating in increasingly competitive and turbulent environments, under the combined forces of globalization, telecommunications revolution and increasing work/labor mobility. One could argue that the only potential exceptions could perhaps be monopolistic or oligarchic firms, but even in those cases firms are not necessarily immune e.g. Google could be considered to have a monopoly in the search business, with market share in excess of 60%-70%. However, as pointed out by their chairman Eric Schmidt, they believe that they too operate in a turbulent environment where each customer is just a click away from moving to the competition, if Google’s service is not perceived to be satisfactory by the customer for every and any search (Senate Judiciary Committee hearing, 9/21/11). Recent research (McAfee & Brynjolfsson, 2008) indicates that in the last decade, these competitive dynamics have only accelerated, with three key outcomes – a) the gap between the leaders and the laggards within an industry is increasing rapidly, based on measures of sales, profits and market capitalization i.e. the leaders are now increasingly breaking away from the pack; b) the industries are increasingly evolving into markets characterized by concentration and winner takes all and c) even within this concentrated market, there is continuous churn at the top i.e. the Schumpeterian dynamics of ‘creative destruction’ are clearly evident. As an example, in the span of less than a decade, the top search engine crown has moved rapidly from AltaVista to Lycos to
Yahoo and then to Google. It could be argued that these factors are perhaps in play only in digital firms or knowledge intensive industries e.g. Google, Amazon, etc. However research also shows the new trend of these competitive dynamics accelerating even in traditional industries like manufacturing and retail. There also appears to be some evidence that these dynamic changes are more pronounced in IT-intensive industries e.g. consumer products.

Second, concomitantly over the last two decades, firms have seen the enterprise-wide deployment of complex innovations called enterprise systems, primarily driven by implementations of enterprise resource planning (ERP) systems. The rapid and widespread deployment of enterprise systems can be gauged by the fact that in less than a decade since the early 1990s, 76% of manufacturers, 35% of insurance and health care companies, 24% of Federal Government agencies and 60% of the U.S. Fortune 1000 companies had implemented an ERP system (Stedman, 1999; Stein, 1999), and in less than two decades it was claimed by SAP (the largest ERP vendor in the world by revenues) that “70% of the world economy’s transactions touch an SAP system in some way, shape or form” (SAP announcement).

ERP systems are large-scale packaged software solutions that integrate and automate many enterprise-wide organizational processes (Davenport, 1998). ERP systems are characterized by three key attributes which distinguish them from earlier classes of information systems. First, ERP solutions incorporate very large scale integration of diverse and disparate enterprise processes such as finance, sales, marketing, operations, manufacturing, warehousing, distribution, product development, human resources, etc. in one common database (Markus & Tanis, 2000). Second, modern ERP
systems are real-time in nature i.e. unlike legacy systems which might have had some level of integration of enterprise processes but operated in batch-processing mode, such ERP systems enable the real-time propagation of “the same information almost instantaneously through one unified user interface” (Bingi, Sharma & Godla, 1999) across almost all functions of the firm. At the same time, since ERP solutions are purchased or leased by a large number of organizations from a single software vendor, they are not built around the specific business processes of an individual organization (Sharma & Yetton, 2003), but are designed around business models which are considered to be best practices by the ERP vendor (Wagner, Scott & Galliers, 2006). Because of these key characteristics ERP systems are often considered transformational in nature.

Scholars in strategic management and marketing discipline have studied in great detail the highly dynamic environment in which organizations operate today, and identified that competitive, globalized and time-to-market pressures require organizational agility (Goldman, Nagel & Preiss, 1995), defined by Sambamurthy, Bharadwaj & Grover (2003) as “the ability to detect opportunities for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise”. Similarly, scholars in information systems and operations discipline have studied enterprise systems too in great detail, along multiple dimensions of usage (Chen, 2001; Markus & Tanis, 2000), implementation and critical success factors (Dowlatshahi, 2005; Hong & Kim, 2002; Motwani, Subramanian & Gopalakrishna, 2005; Sumner, 2000; Gargeya & Brady, 2005), change management (Soh & Sia, 2004), etc. Cross-disciplinary research suggests that information systems in general may support agility at an organizational level (Sambamurthy et al., 2003;
Sanchez, 1995). However, while research is fairly conclusive that enterprise systems have been a strong contributor to increased efficiency and productivity in organizations, literature review indicates that there is a specific gap in helping understand the impact of large-scale, highly integrated, transformational and complex innovations like enterprise systems on organizational agility. Relatively little is known about enterprise systems and organizational agility along the dimensions of organizational impact, organizational processes and organizational knowledge, which form the broad basis for the following research questions in this dissertation –

1. What is the impact of enterprise systems on organizational agility? Specifically and empirically, do enterprise systems promote or hinder agility?
2. What are the organizational processes by which organizations reconcile continually changing business needs driven by organizational agility with enterprise systems?
3. What are the effects of organizational knowledge and competencies on the impact of enterprise systems on organizational agility?

**Importance of Topic**

The research topic in this dissertation has significant importance from both, a theoretical perspective as well as a practitioner perspective.

From a theoretical perspective, there are four key reasons. First, although there are multiple theoretical frameworks in strategic management and information systems discipline on innovations in general and information systems in particular, which could potentially be extended to enterprise systems and organizational agility, there exists no
empirical evidence which can confirm or reject these theoretical frameworks in explaining the impact of enterprise systems on organizational agility. In fact, literature is divided with paradoxical claims that enterprise systems can both promote and hinder organizational agility. This dissertation helps resolve some parts of this paradox. Second, there is a relative dearth of qualitative research in the space of information systems in general, and enterprise systems and organizational agility in particular. The qualitative research in this dissertation, which studies the processes by which organizations reconcile enterprise systems with changes driven by agility, provides a rich, textured and nuanced perspective, which can serve as input for new theory generation. Third, this research provides insight into theoretical implications and limitations of organizational knowledge and competencies, in their potentially complex interaction between enterprise systems and organizational agility. Finally, it is well understood that enterprise systems are a special class of information systems, which due to their unique characteristics amongst information systems could be argued to operate at an extremity of scale, in terms of scope of functionality as well as depth of integration. This research helps understand the applicability of existing theoretical frameworks at potentially the boundary conditions of such scale, and possibly lead to the extension of such frameworks to operate beyond the current boundary conditions.

From a practitioner perspective, there are three key reasons on why this topic is important, based on the experience of this PhD candidate as a prior practitioner and executive. First, in recent years the conversation in the C-suite has dramatically shifted towards organizational agility as a source for creating value in a firm, as well as the organizational and managerial factors which can influence or limit such agility (Hugos,
Hence this research topic is timely in its applicability for management executives. Second, there is increased focus in the CIO-suite on enterprise systems, typically driven by the high sunk costs in implementations and license fees (together typically ranging in the millions of dollars), perceived high failure rates even in post-implementation phase, and high on-going maintenance costs (Vaman, 2008; Wailgum, 2008). Such focus is all the more heightened due to a widely held practitioner perspective that enterprise systems introduce rigidity in an organization and hinder an organization’s ability to be agile, due to the tight integration and coupling between business processes, which generates additional complexity and correspondingly increased rigidity (Goodhue, Chen, Boudreau, Davis, & Cochran, 2009). Although most business cases for enterprise system implementations are built around improved efficiency and productivity, IT executives are increasingly seeking clarity on whether such multi-million dollar assets can help or impede their efforts to be agile and compete aggressively. This dissertation helps provide insights which increase that clarity. Finally, this research can be important to practitioners, since it provides managerially actionable insights into how organizational processes influence agility, as well as how organizational knowledge and competencies can be managed to drive organizational agility under varying conditions.

Recent research (O’Brien et al., 2010) has highlighted that scholarly research in business and management schools has come under criticism by business practitioners, based on irrelevance of topic (Bennis & Toole, 2005). The source of such criticism has not been limited to practice. Scholars themselves are increasingly suggesting that business and management research has tended to focus on esoteric theory (Hambrick,
2007) rather than value to practice (Bartunek, 2007; Pfeffer, 2007). The research topic of this dissertation on organizational agility and complex system innovations like enterprise systems lies at the intersection of both scholarly theory as well as relevant practice, since it not only identifies and addresses a theoretical gap, but it also seeks to generate actionable insights relevant to managerial practice. Hence it can be argued to be an important topic of research for both scholars and practitioners.

**Literature Review**

The literature review for this dissertation is structured as follows. I will first briefly review the definitions of enterprise systems and associated enterprise resource planning (ERP) systems, as well as the evolution of such enterprise systems from their manufacturing-based roots in the 1950s to their current structure as an enterprise application portfolio. I will then leverage complex systems literature as well as innovation literature to show that enterprise systems can be viewed as complex system innovations. Next, I will switch tracks to the central construct in this dissertation of organizational agility, and leverage literature from strategic management, operations management, marketing and information systems to a) review the evolving definitions of organizational agility, as well as b) discuss the antecedents identified by researchers to organizational agility. Since enterprise systems can be viewed as innovations, I also include a discussion on innovations as antecedents to organizational agility. Finally, having derived theoretical motivations from literature to link enterprise systems to complex system innovations and innovations to organizational agility, I will build a theory base to help understand the theoretical relationship between complex system innovations like
enterprise systems and organizational agility using three multi-disciplinary theory streams based on resource-based, capabilities-based and knowledge-based views of a firm.

Enterprise Systems

*ERP (Enterprise Resource Planning) systems* typically are large-scale transaction processing software solutions that integrate and automate enterprise-wide organizational processes in the form of ‘best practices’ (Davenport, 1998). On the other hand, enterprise systems are a portfolio of information systems implemented enterprise-wide, which integrate transaction processing *with* data analysis, data reporting and data flow across enterprise-wide and cross-enterprise units, functions and processes. Typically enterprise systems *comprise* of core transactional systems like ERP systems, supplemented and potentially tightly integrated with additional applications like business intelligence (BI), customer relationship management (CRM), supplier relationship management (SRM), etc. Since ERP systems typically form the *core foundation* of enterprise systems, the terms ‘ERP systems’ and ‘enterprise systems’ will be used interchangeably and synonymously in this dissertation.

Evolution of Enterprise Systems

Literature review reveals a multitude of studies (Klaus, Rosemann, & Gable, 2000; McGaughey & Gunasekaran, 2009; Rashid et al., 2002) which trace the origin of enterprise system from its roots in MRP (material requirements planning) to its current iteration of ERP. Although the specific terminologies and timeframes have varied across the studies, the stages of evolution are generally consistent. Such evolution has generally
unfolded along two key paths – functionality and technology.

**Functionality**

The core functionality of ERP systems originated in material requirements planning (MRP) systems in the 1950s, when MRP systems were amongst the first business applications to be designed, along with general ledger and accounting packages (Orlicky, 1975). MRP software supported inventory management through a centralized material master database for all products, parts and BOM (bill-of-material) across all plants in a firm. MRP was extended in the 1970s across the entire manufacturing plant to MRPII (manufacturing resource planning), with support for entire production planning processes which incorporated a) demand planning using long range sales forecast, b) materials planning using stock inventory and c) capacity planning using available machines and work stations. The MRPII approach was extended in the 1980s to incorporate integrated product development and production processes (Chung & Snyder, 2000) to give rise to computer-aided (CA) functions - computer aided engineering (CAE), computer aided design (CAD) and computer aided manufacturing (CAM), collectively named computer integrated manufacturing (CIM) (Scheer, 1994). In the early 1990s, MRPII underwent large scale functional integration with non-manufacturing processes across the enterprise, including sales, finance, distribution, human resources, etc. to be called enterprise resource planning (ERP) systems. The term ERP was probably referenced in literature for the first time in 1992 (Lindholm, 1992; Lopes, 1992; Ricciuti, 1992). ERP systems finally evolved in their last iteration through tight integration with a) processes outside the enterprise e.g. customer relationship management (CRM) for
customers and supplier relationship management (SRM) for vendors as well as b) with data warehouses and analytics e.g. business intelligence (BI), to be called enterprise systems or ERPII (McGaughey & Gunasekaran, 2009).

Technology

In the period 1960s-1980s, the technologies underlying MRP and MRPII systems were predominantly mainframe based with access through ‘green-screen’ terminals (Klaus et al., 2000). In the 1990s, ERP systems generally evolved to UNIX based three-tier client-server architecture, in which the system functionality is performed in three logically independent levels of presentation layer (graphical user interface), application layer (business rules/logic) and database layer (typically SQL based relational database management systems) (Rashid et al., 2002). Such client-server architecture improved the scalability, reliability and interoperability of enterprise systems vis-à-vis the earlier mainframe technologies. In the early 2000s, the technology further evolved through incorporation of Internet technologies including Web services, intranets and extranets, allowing easy user access through a standard browser-based user interface (McGaughey & Gunasekaran, 2009). In recent years, enterprise systems have seen an increasing push towards cloud technologies, where the enterprise suite of applications is designed to be hosted offsite in the ‘cloud’, with access typically through a standard browser (Hoffman, 2008). Multiple value propositions are available for ‘cloud ERP’, in the form of software-as-a-service (SaaS), platform-as-a-service(PaaS) and infrastructure-as-a-service(IaaS), all of which offer varying levels of scalability, flexibility and reliability with correspondingly differing levels of ‘digital options’ available to firms for utilizing
enterprise systems (Raihana, 2012; Sambamurthy et al., 2003).

**Enterprise Systems as Complex System Innovations**

A system is an interconnection of parts such that they not only *interconnect* with each other but are also *interdependent* to some degree on each other. Ramalingam & Jones (2008) have characterized complex systems with the following properties - interconnected and interdependent elements and dimensions, feedback processes which promote and inhibit change within systems, system characteristics and wide-ranging behaviors emerging from simple rules of interaction, non-linearity, sensitivity to initial conditions and presence of adaptive agents. Simon (1962) has argued that hierarchy is a key organizing principle of complex systems, with the presence of interrelated sub-systems that in turn have their own sub-systems i.e. a complex system can be decomposed into a structured ordering of successive sets of *sub-systems*.

I would suggest that enterprise systems can be viewed as complex systems, due to two key reasons. First, from a *functional* perspective, ERP solutions incorporate large scale integration of diverse and disparate enterprise processes such as finance, sales, marketing, manufacturing, warehousing, distribution, product development, etc. (Markus & Tanis 2000). At the same time, since ERP solutions are designed to be standard off-the-shelf packages which can be implemented across various firms in multiple industries, they are built around an architecture of standardized functional modules which are *interconnected* to each other through standard data interfaces as well as are *interdependent* on each other through integrated data flows. In order to tailor ERP systems to the specific requirements of individual firms, they can be individualized
through a process called ‘customizing’, during which system behavior choices are made through a selection from amongst a large number of simple rules (e.g. simple checkboxes, table entries), the outcome of which are system characteristics which are both wide-ranging as well as complex (e.g. pricing routines). Second, from a technology perspective, modern enterprise systems are built around multi-level client server architecture. Each level in this architecture (presentation, application and database) is further comprised of technical systems and sub-systems which are inter-dependent and interconnected with each other, all of which can be dynamically reconfigured with simple rules to achieve complex configurations, to meet desired outcomes of scalability and flexibility. Thus, due to this large scale integration of wide range of business processes, deep interdependency inherently built around standardized modules in the systems and the modular, highly configurable as well as customizable nature of the sub-systems based on simple rules, it can be argued that ERP systems are highly complex systems.

An innovation is defined as “any idea, practice or object that is perceived as new by the adopter” (Fichman, 1992). Enterprise systems are relatively recent in their evolution and wide spread deployment in firms over the last two decades e.g. the largest ERP vendor SAP introduced their best selling ERP platform of R/3 only in the early 1990s (Hoffman, 2008). Hence enterprise systems can also be viewed as innovations.

Since enterprise systems can be viewed as both complex systems and as innovations, I will argue in this dissertation that enterprise systems can be viewed as complex system innovations. The reasons for doing so are two-fold. First, the characterization of enterprise systems as complex systems provides a tool for de-layering the underlying sub-systems to analyze their impact on organizational agility. Second and
more important for this dissertation, the characterization of enterprise systems as *innovations* opens up usage of tools from innovation literature, to build theoretical frameworks for analysis of *effects* of enterprise systems on organizational agility. Specifically, I will leverage *innovation literature* to show that apart from other antecedents to organizational agility, *effects* of innovations can act as important antecedents. Ergo, *effects* of enterprise systems can act as antecedents to organizational agility. Subsequently (in Chapter 2), I will leverage *innovation assimilation literature* to show that *assimilation* of innovations has a *key effect* on organizational agility. Hence, *assimilation of ERP systems* can be used to build a theoretical model (that I will use subsequently in Chapters 2 and 4 of this dissertation) to explain the *mechanism* by which enterprise systems may impact organizational agility. *Innovation assimilation* can also be used to theorize potential and novel *levers* (e.g. systems agility, organizational competencies) which can be studied for *changing* such impact of enterprise systems on organizational agility.

Next, I will switch tracks to review literature on definitions, dimensions and antecedents of organizational agility.

*Organizational Agility – Definitions and Dimensions*

Review of the literature in strategic management, operations, marketing and information systems reveals that organizational agility has been studied in great detail across multiple disciplines. However the definition and nature of organizational agility has continued to evolve with time and across disciplines from *decision making speed* to *flexibility*, to *strategic flexibility* and finally to *agility*, leading to a potential lack of
theoretical clarity for the construct (Schnackenberg, Singh, & Hill, 2011). The evolution of these definitions of organization agility along with their corresponding dimensions is covered next.

One of the earliest dimensions of organizational agility was identified in strategic management discipline by Judge & Miller (1991) as decision making speed, based on the concept of strategic decision making in ‘high-velocity’ environments from Eisenhardt (1989). Another key dimension that emerged subsequently was that of flexibility. Bahrami (1992) defined flexibility as the “ability to change rapidly to take advantage of emergent opportunities and/or side-step threats” and suggested flexibility having offensive characteristics of agility and versatility as well as defensive characteristics of robustness and resilience. Hayes & Pisano (1994) extended this concept in operations management as strategic flexibility, arguing that when organizations move from stable environments to turbulent environments, the organizational goal shifts from competitive strategy to strategic flexibility, defined as “the ability to switch gears from rapid product development to low cost production relatively quickly and with minimal resources”.

Although both constructs of flexibility and strategic flexibility have an element of speed implicitly embedded in them, the focus of their definitions seems to be more on ease of change than speed of change.

Contemporary research has increasingly evolved from the construct of strategic flexibility to the construct of agility, almost all of whose definitions are characterized by a dimension of sensing the environment and a corresponding dimension of responding with adaptive change. One of the first to make the transition from strategic flexibility to agility was Sambamurthy et al. (2003), who defined agility as “the ability to detect opportunities
for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise”, with dimensions of customer agility, partnering agility and operational agility. Sull (2009) approached it from a practitioner perspective by defining agility as the “capacity to identify, capture, and exploit opportunities more quickly than rivals do”. Unlike other definitions which identified agility as a capability, this definition distinguished agility as a capacity, thus implying that it was a range of sense and response rather than a specific scale point of sense and response, as conceptualized by earlier definitions.

Recently, in addition to the focus on sense and response mechanism, Tallon & Pinsonneault (2011) has emphasized the ease of sense and response as well as the ambidexterity needed in balancing the exploration and exploitation aspects, by defining agility as the “ability to detect and respond to opportunities and threats in the environment with ease, speed and dexterity”. Similarly, Overby, Bharadwaj & Sambamurthy (2006) have drawn attention to the dimension of appropriateness of the response, which implies that the response is in line with organizational goals, such as market share, customers and competition. Although such a dimension appears obvious and implicit, it is critical as exemplified by Overby et al. (2006) in “…an analogy is the squirrel in the road. The pending environmental change that the squirrel senses is that there's a car coming down the road. The squirrel responds by running back and forth, but its response is not appropriate because it gets run over.”

For this dissertation, the following definition of organizational agility (Tallon & Pinsonneault, 2011) is used:
“(Organizational) agility (is) defined as the ability to detect and respond to opportunities and threats in the environment with ease, speed and dexterity” (Tallon & Pinsonneault, 2011, p. 464)

This definition not only emphasizes and highlights the three characteristics of speed of change, ease of change and sensing/responding, but also adds a dimension of dexterity implying the need for organizations to achieve an appropriate balance amongst competing requirements.

**Antecedents to Organizational Agility**

Literature review indicates extensive research by scholars on antecedents to organizational agility. Four categories of antecedents that will be covered here are modularity, organizational structures, organizational knowledge and innovations, since they have the potential to give insights for the research questions in this dissertation.

Modularity has been defined as “a form of design which intentionally creates a high degree of independence or ‘loose coupling’ between component designs by standardizing component interface specifications” (Sanchez & Mahoney, 1996). Higher modularity corresponds to lower coupling which requires less managerial coordination, since a change in one component design does not require as much corresponding changes in the designs of other interrelated components. Lower managerial coordination will result in higher organizational agility due to faster decision making and lower execution time for changes in response to turbulent market environment. Examples of modularity in influencing organizational agility are product modularity (Sanchez, 1995) and process modularity (Tallon, 2008). An outcome of product modularity in influencing agility is
product variety, where a variety of products offered, driven by modular product architecture, has been empirically found to be a key enabler of organizational agility (Worren, Moore, & Cardona, 2002).

Types of organizational structures have been argued by researchers to have a role in influencing organizational agility. In terms of intra-organizational structures, a decentralized organizational structure has been suggested as a source of lower cost for adaptive coordination in responding to environmental changes, thereby increasing organizational agility (Sanchez & Mahoney, 1996). At the same time, a contrarian point of view for the centralization of organizational structures has been proposed in literature, with diversified companies in industries undergoing rapid changes needing more direction, not less, from corporate headquarters in defining the scope of division level strategy, for the overall organization to be agile (Raynor & Bower, 2001). A case for permeable structures within the organization has also been made through the use of contingent workforce, resulting in rapid knowledge transfer both ways across the unit boundaries and leading to higher organizational agility (Matusik & Hill, 1998).

In terms of inter-organizational structures, the nature of the relationship between organizations appears to drive the impact of the structure on organizational agility. Thus, based on transaction cost economics and social exchange theory, strategic alliances with external organizations have been found to increase organizational agility (Young-Ybarra & Wiersema, 1999). At the same time, joint ventures have been found to lower organizational agility than having wholly owned subsidiaries, amongst multi-national enterprises, due to higher exit costs in fast-changing environments (Belderbos & Zou, 2007). Similarly, collective strategy (i.e. collaboration with other organizations in same
environment) while helping deal with variation in inter-organizational environment, has been found to increase inter-connectedness through contractual obligations, thereby decreasing organizational agility (Bresser & Harl, 1986).

Dynamic markets require managerial willingness to redefine organizational strategies which varies inversely with perceived risk associated with change (Baird & Thomas, 1985). Perceived risk in turbulent environments can be reduced when managers can increase organizational knowledge and reduce ambiguity, thereby increasing organizational agility (Eisenhardt, 1990). Specifically, increase in organizational knowledge through organizational learning and training has been empirically shown to increase organizational agility (Berk & Kase, 2010).

Innovations have been theorized in innovation literature to influence organizational agility based on the concept of organizational inertia (Zhou & Wu, 2010), defined as “the stability in products and processes, which influences the insufficient organizational adaptation to changing business conditions” (Hannan & Freeman, 1984). Organizational inertia is driven by organizational routines put in place for increased efficiency and reliability, but over time such routines are also responsible for generating strong pressure and resistance to changes from the status quo. Organizational inertia can be classified into two categories – a) resource inertia based on inertia in resource allocation and b) process inertia based on inertia in organizational processes that utilize the resources (Gilbert, 2005). The introduction of innovations in an organization results in the integration of new products and processes in the organization (Fichman, 1992), which can be of aid in reducing resource inertia and product inertia respectively. Decreased product inertia and process inertia can help firms adapt to turbulent
environments with appropriate changes, resulting in increased organizational agility. Thus, the *adoption* of innovations in a firm may result in decreased organizational inertia which can lead to an *increase* in organizational agility. Examples of innovations that can influence organizational agility are technological innovations (Sanchez, 1995; Zhou & Wu, 2010), managerial innovations (Sanchez & Mahoney, 1996; Shimizu & Hitt, 2004) and process innovations (McAfee & Brynjolfsson, 2008).

**Organizational Agility and Complex Enterprise System Innovations**

As noted earlier, since enterprise systems can be viewed as complex system innovations, and innovations can be considered to be antecedents to organizational agility, ergo enterprise systems can be considered as a platform for organizational agility. However, to gain insights into the *mechanisms* through which such complex enterprise system innovations can influence organizational agility, it is a necessary to have a theory base which can serve as a theoretical lens for the research questions outlined earlier for this dissertation. In order to identify the *right* theory base, I went back to the research questions and systematically started an iterative process of deeply and clearly understanding the *core* elements in the research questions, and their *nature*, *characteristics* and *attributes*. At the core, the research questions start out with enterprise systems. Literature from information systems discipline on enterprise systems give multiple definitions of enterprise systems and enterprise resource planning (ERP) systems (Davenport, 1998; Markus & Tanis, 2000), however almost all of the definitions characterize them as a *resource*, similar to other resources that together form the ‘*collection*’ that constitutes a firm (Penrose, 1959). Strategic management discipline has
extensively theorized on resources (Grant, 1991; Penrose, 1959; Wernerfelt, 1984), with *resource-based view* (RBV) (Barney, 1991) being one of the most well-known theoretical frameworks. Wade & Hulland (2004) have argued that RBV provides “provides a cogent framework to evaluate the strategic value of information systems resources”. Based on this triangulation between literature in strategic management and information systems discipline, it was decided to use RBV as a key theory base for this dissertation.

The other core element in the research questions is organizational agility. One minimalistic commonality across all the characterizations around organizational agility is that organizational agility is considered to be a *capability*. Additionally, literature review of the RBV theory base highlighted the shortcomings of RBV and a *process*-focused framework called *capabilities-based view* (CBV) – more specifically *dynamic capabilities* in fast-paced environments - was suggested as an extension of RBV to address such limitations (Barney, 1996; Teece, Pisano, & Shuen, 1997). It was also noted that a key research objective in this research was to gain an understanding of the reconciliation *process* between changes driven by organizational agility and enterprise systems. Based on this triangulation between the intrinsic nature of organizational agility, the limitation of the RBV theory base and the process-oriented nature of a key research question, it was decided to add CBV to the theory base.

A deeper diver into the capabilities-based view revealed the critical nature of *knowledge* and competencies as a foundational mechanism for the operationalization of dynamic capabilities (Eisenhardt & Martin, 2000). Additionally, one of the focus areas of the research questions of this dissertation is to understand the interaction of organizational *knowledge* on the impact of enterprise systems on organizational agility. In
their seminal work, Sambamurthy et al. (2003) have provided a knowledge-based view on information systems and agility. Hence it was decided to leverage this theoretical framework and add a knowledge-based view to our theory base.

The following sections cover how these three multi-disciplinary theory streams – resource-based, capabilities-based and knowledge-based - served as a theoretical basis to help understand the relationship between enterprise systems and organizational agility.

Resource Based View (RBV)

Sanchez (1995) has strongly argued on a resource based view of organizational agility and information technologies, which can be extended to enterprise systems, since they are a class of information technologies. In his theoretical framework, he has pointed out that organizations operating in turbulent environments are characterized by high levels of uncertainty. This was corroborated by Kahn (1994) who found that turbulence increases uncertainty. Since there is no single best plan for addressing this uncertainty, an organization can achieve competitive advantage by creating “alternative courses of actions” i.e. strategic options. Organizations are often conceptualized as ‘a collection of productive resources’ (Penrose, 1959). Resources themselves cannot be viewed as input into an organization. The services of the resources are the input, which are obtained through resource use. Thus it can be argued that organizational agility is constrained by the ways in which organizations use available resources. Use of available resources depends on the flexibilities of the resources available to the organization, as well as on the organization’s flexibilities in applying those resources to different courses of action. Hence Sanchez (1995) claims that the key to organizations in responding to dynamic
markets is in a) identifying and acquiring the use of flexible resources that can provide strategic options to pursue alternative courses of actions and b) developing flexibility in coordinating the use of resources to maximize the flexibilities present in the resources. Thus organizational agility maps to resource flexibility and coordination flexibility.

Resource flexibility can be increased in three ways – a) increasing the number of alternative uses to which a resource can be applied, b) lowering the costs and difficulty of switching from one resource to another and c) lowering the time required to switch to an alternate resource. ERP systems are a class of information technologies which due to their highly customizable, configurable, modular and integrated structure allow business processes within an organization to be reconfigured to support a range of alternative resources (e.g. new material in a component of a bill of material (BOM) of a product) while at the same time lowering the cost and time of switching such resources, vis-à-vis organizations without ERP systems. At the same time, since ERP systems have a wider range of business processes integrated in them ranging from design, development, sales, distribution, production and finance, this resource flexibility is extended across the organization when compared to organizations with non-integrated information technologies (e.g. rapid propagation of the updated BOM with the new material through integrated processes in ERP of purchasing, pricing, manufacturing, etc). Thus ERP adaptation can be of aid in resource flexibility.

Coordination has been defined as the “way in which subdivided functions and interests are resynthesized” (Andrews, 1980). Coordination involves defining strategies, configuring “chains of resources” in support of organizational processes from ideation to market and deploying resources in support of organizational strategies. Sanchez (1995)
states that in dynamic environments, coordination flexibility translates to “redefinition, reconfiguration and redeployment” of organizational strategy. Managerial willingness to redefine organizational strategies varies inversely with the perceived risk and difficulty of adapting technology associated with change (Baird & Thomas, 1985; Hitt & Tyler, 1991). Perceived risk in turbulent environments can be reduced when managers can obtain current information about how customers are responding to an organization’s products as well as competitive products (Eisenhardt, 1990). Effective use by managers of integrated components of ERP systems such as business intelligence (BI) and customer relationship management (CRM) to obtain such product or customer information may help resolve market uncertainties quickly and accurately, leading to lowered perceived risks in support of iterative redefinition, reconfiguration and redeployment of organizational strategies. Thus ERP adoption can be of aid in increasing coordination flexibility.

Since information technologies like ERP can help in increasing both resource flexibility and coordination flexibility, it can be argued from a resource based view that adoption as well as adaptation of enterprise systems like ERP positively influences organizational agility.

Sambamurthy et al. (2003) have highlighted the limitations of a resource based view (RBV) on organizational agility enterprise systems. According to them, RBV has “weaker ability to explain competitive strategic conduct in fast-paced business environments”. Literature from strategic management stream has also critiqued RBV that it “reaches a boundary condition in high velocity markets” (Eisenhardt & Martin, 2000). Tallon & Pinsonneault (2011) have pointed out that when resources are long term
committed with “an intent to maintain strategic direction’, organizations may focus on extracting value from the resources and resist change. Finally, RBV does not provide detailed insight into the processes by which the resources contribute to turbulent environments. Since a key research objective in this dissertation proposal is to understand the processes by which organizations reconcile changing business needs driven by the need for agility with enterprise systems, the capabilities based view is covered next, which addresses some of these shortcomings of RBV.

Capabilities Based View (CBV)

Literature review indicates that there are multiple definitions of organizational capabilities. Collis (1994) has summarized them into three broad categories –

- Ability to perform basic activities in an organization (Amit & Schoekmaker, 1993; Grant, 1991; Stalk et al., 1992)
- Dynamic improvements to organizational activities (“the ability of an organization to learn, adapt, change and renew over time” - Teece et al., 1997, “to switch gears – from for example, rapid product development to low cost – relatively quickly and with minimal resources” - Hayes & Pisano, 1994)
- Strategic insights that allow organizations to recognize intrinsic value of resources before competitors (“organizational abilities to deploy the firm’s resources and to develop new ones” – Henderson & Cockburn, 1994)

Since the focus of this dissertation is on enterprise systems and organizational agility, the second category with its focus on dynamic capabilities is applicable.
Similarly, since enterprise systems are a class of information technologies (IT), we will extend that view to dynamic IT capabilities.

As noted, organizational agility has two critical components of a) sensing capability and b) responding capability (Overby et al., 2006). IT solutions like enterprise systems provide dynamic IT capabilities which play a role in enabling both – sensing and responding – capabilities (Bradley & Nolan, 1998; Sambamurthy et al., 2003), as per below.

In contemporary business environments, the volume of information that is generated in a competitive environment and which must be sensed by the organization far exceeds the capability and capacity of human beings to process them. Enterprise systems, through their large-scale integration with partner systems (e.g. point-of-sale (POS) information from big box retailers) or with social networks (e.g. product feedback on Facebook and Twitter), help augment that human processing capacity with enhanced sensing capabilities, so that managers can make sense of what might otherwise be overlooked or misunderstood. Such management in turbulent environments with processes aided by information systems, which might otherwise be overwhelming, has been termed as “managing by wire” (Haeckel & Nolan, 1993).

In response, organizations often need to change their business processes and product strategies. Since such business processes are enabled and embedded in enterprise systems, organizations need systems development capabilities to address the changes, e.g. changes in customer and vendor relationships as well as pricing changes in response to environmental changes (Overby et al., 2006). Although literature is divided on the extent and speed with which ERP systems enable such changes, it is generally agreed upon that
ERP systems provide processes which positively influence such systems development capabilities when compared with organizations with non-integrated systems, resulting in enhanced responding capabilities for the organization.

Thus enterprise systems can be considered to be enablers of organizational processes which allow enhanced capabilities to the organization for sensing changes in turbulent environments as well as for responding effectively to them.

It is important to understand that dynamic capabilities are essentially specific organizational processes by which resources are manipulated in response to changes from dynamic markets. In moderately dynamic markets, such processes are similar to routines which extensively utilize existing detailed organizational knowledge. On the other hand, in highly dynamic market - termed “high velocity” by Eisenhardt (1989) - such processes are adaptive processes which extensively use simple and “rapidly created new knowledge” to produce desired outcomes (Eisenhardt & Martin, 2000). In either case, knowledge and associated competencies are the underlying basis for the operation of dynamic capabilities in dynamic markets. Since another key research objective in this dissertation proposal is to understand the effects of key organizational knowledge and competencies on the impact of enterprise systems on organizational agility, the knowledge based view is covered next.

Knowledge Based View (KBV)

An organization’s knowledge is a key resource which is valuable, rare, inimitable and hence a source of competitive advantage (Barney, 1986, 1991; Prahalad & Hamel, 1990). Sambamurthy et al. (2003) have argued that information technologies like
enterprise systems support organizational agility by providing firms with digital options, which are defined as “a set of IT-enabled capabilities in the form of digitized work processes and knowledge systems”. Such digital options are created by improving upon the “reach and richness” (Sambamurthy et al., 2003) of the organization’s knowledge.

Overby et al. (2006) have applied this framework of knowledge “reach and richness” to information systems. Knowledge reach refers to the comprehensiveness of the interlinked knowledge available to an organization in multiple databases, both within and outside the organization. The central design tenet of enterprise systems like ERP is one common integrated database across all the processes in an organization supported by that ERP, such as customers, vendors, products, designs, finances, human resources, etc. In addition, ERP systems are generally well-integrated with databases outside the organization too e.g. partner databases through EDI, point-of-sale databases through the Internet, customer feedback through customer relationship management systems and product feedback through social networks. Based on such large scale as well as better architectured frameworks across multiple information sources, which enable the synthesis of information into knowledge, ERP systems are well positioned to increase knowledge reach in an organization.

ERP systems also enhance knowledge richness by providing information to managers that is not only high quality but also real-time as well as highly customizable. Prior to ERP systems, one could conceivably argue that some limited level of knowledge reach was potentially possible through external albeit limited integration of data across multiple sources. However, it would be difficult to claim that such information could be highly knowledge rich, since it was not real-time and typically available on a batch
schedule e.g. daily, weekly or monthly. At the same time, opportunities for customizing the data in such legacy systems, by slicing and dicing it, were highly limited without expensive systems development resources. However, due to incorporation of modern information technologies in ERP systems like data warehouses, decision support systems and OLAP (online analytical processing), which enable rapid data analysis with minimal specialized system development resources, managers have a rich source of knowledge for sensing environmental changes and responding to it.

Thus, knowledge reach and richness enabled by ERP systems provide digital options by enhancing the sensing and responding capabilities of an organization. As a result, such digital options enable enterprise systems to serve as platforms for agility (Sambamurthy et al., 2003).

Although a knowledge based view of organizational agility and ERP systems appears to provide an adequate explanation on the linkage between ERP systems and organizational agility, its primary weakness has been highlighted by Galliers (2007) that it is primarily human beings who apply their meaning and their knowledge to information, in order to make sense of the data for any specific purpose (Weick, 1995). Information systems like ERP systems can be argued to be simply data collecting, data processing and data integration devices. They still require human beings to apply their sense to data and convert it to information. Hence, such knowledge generally turns out to be not only tacit but also embedded within human beings. It also tends to be ‘sticky’, in the sense that it may be more difficult to transfer from human beings to systems (Szulanski, 1996), than what the knowledge based view above may lead us to believe.
Another critique of the knowledge based view is that knowledge sharing can also limit managerial perspectives by driving a desire to maintain status quo. This is based on the theory that the additional knowledge could drive short-term vision, in putting exploitation of existing resources ahead of exploration of new opportunities, thus impairing organizational agility (Ghemawat & del Sol, 1998; Gibson & Birkinshaw, 2004).

**Prior Research**

Although *prior* multi-dimensional empirical research could not be located, which specifically focused on enterprise systems and organizational agility, a stream of *empirical* research over the last ten years partially overlaps some of the domains within the focus of this dissertation. Table 1 synthesizes and summarizes these key results as well as the potential key gaps in the results. A review of the key results in related research follows.

Liang, Saraf, Hu & Xue (2007) studied the assimilation of enterprise systems in post-implementation phase and the mediatory role of top management in the impact of external institutional pressures, on the assimilation and usage of enterprise systems in organizations. Sample size was 77 organizations in China, who were in the post-implementation phase of ERP. A key contribution from this research was the operationalization of the construct of ERP assimilation. This quantitative study confirmed that top management mediates the effect of *mimetic* and *coercive* institutional pressures on ERP assimilation, but does not mediate the impact of *normative* pressure on ERP assimilation.
Goodhue et al. (2009) conducted a series of interviews with business and IT managers in 15 firms, to identify how they addressed agility challenges involving enterprise systems. Their findings were that a large number of such agility challenges were addressed through four options that did not require changes to the core of the complex enterprise system – using built-in capabilities in ERP not currently in use, utilizing existing “globally consistent integrated data” available already in the enterprise system, using third-party bolt-on applications which could be easily interfaced with the enterprise system, and vendor provided “patches” that automatically updated the system.

Tallon & Pinsonneault (2011) conducted a quantitative study to understand the impact of IT alignment on firm agility, and how such firm agility mediates the impact IT alignment on firm performance. The sample size was 241 public traded firm identified by S&P Compustate with sales between $100 million and $3 billion in 2001. The study confirmed that IT alignment positively influences firm agility, which in turn positively influences firm performance, but that there is no direct effect between IT alignment and firm performance. They also found that IT flexibility does not moderate the effect of IT alignment on firm agility, although IT flexibility does positively influence firm agility.

Lu & Ramamurthy (2011) conducted a quantitative study to understand how IT capability (conceptualized along three dimensions of IT infrastructure capability, IT business spanning capability and IT proactive stance) influences organizational agility (conceptualized along two dimensions of market capitalizing agility and operational adjustment agility). The sample size was 128 mid-sized firms in Midwestern states of the United States. The study found that IT capability enhances both types of agility (market capitalizing agility and operational adjustment agility) as well as IT spending moderated
the effect of IT capability on operational adjustment agility, but not on market capitalizing agility.

**TABLE 1**
**Synthesis of Prior Research**

<table>
<thead>
<tr>
<th>References</th>
<th>Key Results</th>
<th>Key Gaps/Issues</th>
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| Lucas & Olson     | • Information technology can influence organizational flexibility by  
                     ✓ changing organization boundaries and the time when work occurs  
                     ✓ altering the nature and pace of work  
                     ✓ helping organizations in *response* ability for changing market dynamics. | • Using construct of organizational flexibility, focus is on “ease of change” rather than “speed of change”.  
                     • Sample data limited to two industries and three firms |
<p>| (1994)            |                                                                                                                                                                                                            |                                                                                                     |</p>
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<th>References</th>
<th>Key Results</th>
<th>Key Gaps/Issues</th>
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| Sanchez(1995)                 | • Information system resources provide a new “logic for competing in dynamic product markets” | • Limited construct of strategic flexibility vis-à-vis organizational agility  
|                               |                                                                             | • Study limited to CAD/CIM systems                                   |
| Zaheer & Zaheer (1997)        | • Proactive use of information resources influences alertness and responsiveness in highly dynamic markets like currency trading industry | • Information resources in the study are highly limited to information communication networks and cannot be generalized across information systems. |
| van Oosterhout et al. (2006)  | • Inflexible IT systems disable agility in times of rapid unpredictable changes  
<p>|                               | • Agile processes and IS architectures enable org. agility.                  | • Processes/mechanisms for the influence of architectures on org. agility as well as their potential outcomes are not a key part of study. |</p>
<table>
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<tr>
<th>References</th>
<th>Key Results</th>
<th>Key Gaps/Issues</th>
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<tbody>
<tr>
<td>Liang et al. (2007)</td>
<td>• Institutional pressures influence ERP assimilation through top leadership</td>
<td>• ERP assimilation instrument does not comprehensively address dimensions of diffusion and routinization in definition of assimilation.</td>
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<tr>
<td></td>
<td></td>
<td>• Limited sample size of 77</td>
</tr>
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<td>Goodhue et al. (2009)</td>
<td>• Firms addressed agility challenges by exercising four options on enterprise systems – unused built-in capabilities, using “globally consistent integrated data”, third-party add-ons and vendor provided “patches”</td>
<td>• Limited data based on case study of 15 firms</td>
</tr>
<tr>
<td>Tallon &amp; Pinsonneault (2011)</td>
<td>• IT alignment positively influences firm agility which in turn positively influences firm performance</td>
<td>• Impact of specific information systems like enterprise systems on org. agility is not considered</td>
</tr>
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<td></td>
<td>• IT flexibility does not moderate the effect of IT alignment on firm agility</td>
<td>• Does not give insight into factors driving IT alignment</td>
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<td>References</td>
<td>Key Results</td>
<td>Key Gaps/Issues</td>
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<tr>
<td>Lu &amp; Ramamurthy (2011)</td>
<td>• IT capability (as measured across infrastructure, business span and proactive stance) positively influences org. agility (as measured along market capitalizing and operational adjustment dimensions)</td>
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<td></td>
<td>• IT spending moderates the influences of IT capability on operational adjustment agility</td>
<td>• Does not address specifically the impact of enterprise systems or applications on org. agility</td>
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<td>• Does not distinguish between agility in highly dynamic markets versus moderately/low dynamic markets</td>
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<td>• Inconsistent dimensions of org. agility vis-à-vis previous empirical studies make it difficult to compare results.</td>
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**Research Scope**

**What is Known**

From the literature review, we know that enterprise systems form a class of information systems which can be categorized as *complex system innovations*, based on their functional and technical design, structure, deployment and usage. We know that the construct of organizational agility lacks theoretical clarity in terms of its definition as
well as its dimensions. However it can generally be considered to have three key characteristics in the context of dynamic markets – speed of change, ease of change and a sensing/responding mechanism. We know of several key antecedents to organizational agility – product and process modularity, product variety, modularity in organizational design, loose coupling in organizational structures, permeability through contingent workforce and organizational knowledge. Adoption of innovations is also an antecedent to organizational agility, due to its role in decreasing organizational inertia and corresponding increase in adaptive changes. Since enterprise systems can be considered to be complex system innovations, we know that they can be considered to be an antecedent of organizational agility.

We know that the mechanism for the influence of enterprise systems on organizational agility can be explained by resource-based views (RBV), capabilities-based (CBV) views and knowledge-based (KBV) views of a firm. RBV suggests that enterprise systems may increase resource flexibility and coordination flexibility, with corresponding increase in organizational agility. At the same time, RBV also suggests that based on their high implementation and maintenance costs, executives may be more inclined to utilize enterprise systems to deliver immediate value rather than to use such resources to explore new opportunities with risky returns, thereby decreasing organizational agility. CBV suggests that enterprise systems may lead to enhanced sensing capabilities through “managing by wire” in turbulent environments, leading to an increase in organizational agility. On the other hand, CBV also suggests that the design of enterprise systems around “best-practices” may hinder the ability to develop new capabilities based on new processes and new knowledge, resulting in decreased
organizational agility. KBV indicates that enterprise systems may potentially increase knowledge ‘rich’ and ‘reachness’ in a firm, thereby increasing digital options available to the firm and a corresponding increase in organizational agility. However, KBV also highlights that enhanced knowledge sharing may reinforce positions held by executives that come from what has worked in the past, thus creating a bottleneck when adaptive changes are necessary to support organizational agility.

What is Not Known

Although literature from innovation adoption suggests that innovations like enterprise systems can be antecedents to organizational agility, the magnitude and direction of such influence is not known clearly, based on the competing and sometimes paradoxical perspectives offered on the mechanisms of such influence by resource-based, capabilities-based and knowledge-based views of a firm. An extensive literature search revealed that there are no empirical studies which conclusively address the magnitude and the direction of the influence of enterprise systems on organizational agility. Innovation adoption, being an antecedent to organizational agility, seems to imply simply considering the presence or absence of the innovation and its impact on organizational agility. However, since enterprise systems are complex system innovations, such an approach would be simplistic in accounting for the complex interactions between enterprise systems and their effects on an organization’s ability to be agile i.e. speed, flexibility and sense and response. Hence, an appropriate theoretical framework needs to consider the effects of enterprise systems use and deployment on organizational agility, beyond simply innovation adoption. However, how to theorize and explain such effects
and what they are empirically, is not known. As will be covered in greater detail in Chapter 2, leveraging innovation assimilation literature, I will propose that ERP assimilation defined from Purvis, Sambamurthy & Zmud (2001) as “the extent to which the use of technology (ERP) diffuses across the organizational projects or work processes and becomes routinized in the activities of those projects and processes” is one of the key cause of effects of enterprise systems on organizational agility.

Dynamic capabilities provide a powerful perspective to help understand organizational changes in dynamic markets. Dynamic capabilities are processes and routines that bring about changes in organizational capabilities, which in turn are embedded in other organizational processes. Organizational agility is arguably a dynamic capability, since one of its outcomes is a change in organizational capabilities, in response to changing business environments. Thus, organizational agility can be viewed as higher level organizational processes which bring about a change in baseline organizational processes. In the context of enterprise systems, the specific processes by which organizations reconcile changing business needs driven by agility in turbulent environments, with baseline processes embedded in the enterprise systems, are not known.

Organizational knowledge and corresponding organizational learning are known to be antecedents to organizational agility. At the same time, organizational knowledge is known to be foundational for the operationalization of dynamic capabilities like organizational agility (Eisenhardt & Martin, 2000). In the context of enterprise systems, the specific type of organizational knowledge and competence which has a significant influence on organizational agility is not known conclusively. Similarly, the magnitude
and direction of the influence such of organizational knowledge on the impact enterprise systems on organizational agility is also not known.

**Research Questions**

A careful review of the above analysis reveals that what is not known in the area of enterprise systems and organizational agility constitutes gaps, which can broadly be classified into the three categories of organizational impact, organizational processes and organizational knowledge and competencies. These three gaps form the general basis for the specific research questions addressed in this dissertation and define the scope of the research in this dissertation –

1. What is the impact of enterprise systems (use) on organizational agility? Specifically and empirically, do enterprise systems while being used more extensively, promote or hinder agility?

2. What are the organizational processes by which organizations reconcile continually changing business needs driven by organizational agility, with enterprise systems?

3. What are the effects of organizational knowledge and competencies on the impact of enterprise systems on organizational agility?

**Research Design**

**Overall Design**

The overall design for addressing the research questions in this dissertation takes a mixed methods approach (Creswell, 2009), with the research divided into three distinct
parts. Figure 1 shows the overall design of the research in this dissertation. A summary of each part of the dissertation will follow.

**FIGURE 1**

**Overall Research Design**

Part 1 – Organizational Impact

What is the impact of enterprise systems (use) on organizational agility? Specifically and empirically, do enterprise systems help or hinder agility?

Part 1 proposes a theoretical framework based on innovation assimilation and dynamic capabilities, to address the research question on organizational impact of enterprise systems use on agility. The main idea is to analyze assimilation as a proxy of level and scope of use and to evaluate its impacts on agility. To empirically validate this claim, a theoretical framework combining ERP assimilation and organizational agility is established and validated through a quantitative cross sectorial survey across 215
organizations. In particular, it measures a) the impact of enterprise system assimilation on organizational agility, b) the effect of systems agility ("the ability of the organization to quickly and successfully change its information systems" – Davis, 2009) on organizational agility as well as c) the influence of systems agility on the impact of enterprise system assimilation on organizational agility.

Part 2 – Organizational Processes

**What are the organizational processes by which organizations reconcile continually changing business needs driven by organizational agility, with enterprise systems?**

Part 2 employs a qualitative approach based on grounded theory to address the research question on organizational processes, so as to understand a) how organizations reconcile continually changing business needs driven by agility with existing enterprise systems, as well as b) the outcomes of such reconciliation processes. It studies three diverse organizations – a $9 billion retailer, a $3 billion consumer products firm and a $2 billion logistics company – through semi structured interviews with 24 business and technical professionals, to shed light on the reconciliation process between changing business needs in turbulent environments and enterprise systems.

Part 3 – Organizational Knowledge and Competencies

**What are the effects of organizational knowledge and competencies on the impact of enterprise systems on organizational agility?**

Phase 3 uses a quantitative approach to address the research question of the effects of organizational knowledge and competencies on the impact of enterprise system assimilation on organizational agility. It leverages qualitative research from Part 2 to
identify two specific organizational competencies, which are relevant when organizations are reconciling continually changing business needs with existing ERP systems - a) IT Competence in Business (ITCB) – defined as “the set of IT-related explicit and tacit knowledge that a business manager possesses that enables him or her to exhibit IT leadership in his or her area of business” (Bassellier, Reich, & Benbasat, 2001, p. 159) and b) Business Competence in IT(BCIT) - defined as “the organization-specific knowledge and the interpersonal and management knowledge possessed by IT professionals” (Bassellier & Benbasat, 2004, p. 673). It also leverages the theoretical model from Part 1 to propose an updated theoretical framework, on the dual moderating and mediated effects of ITCB and BCIT on organizational agility. It then utilizes the same dataset collected in Part 1 to empirically validate the updated theoretical framework.

Mixed Methods Approach

Qualitative and quantitative research methods have different philosophical foundations based on positivist and post-positivist paradigms respectively (Lincoln & Guba, 1985). Both research methods also have their perceived strengths and weaknesses. Quantitative research method is argued to be strong in generalizability and replicability, but is considered weak in understanding the context or setting in which actors operate (Creswell, 2009). On the other hand, qualitative research method is perceived to be strong where “behavior in context” needs to be studied and where situational factors are important, but it is considered to be weak in generalization of findings due to typically smaller sample sizes. Quantitative research methods links theory and data through a
deductive reasoning process, making it suitable for theory validation. On the other hand, qualitative research methods links theory and data through an inductive reasoning process, making it suitable for theory generation (Patton, 1990).

In order to identify the appropriate research method for this dissertation, I went back to the research topic and the individual research questions. The broad research topic was to understand the influence of enterprise systems on organizational agility. The specific research questions were along the contexts of organizational impact, organizational processes and organizational knowledge. Thus it was clear that that the research goal was not to simply answer three individual questions, rather the aim was to build a holistic and contextual description of the phenomenon of organizational agility, but coming from different angle i.e. triangulation seemed implicit in the research goals. Formally, triangulation is defined as “the combination of methodologies in the study of the same phenomenon” (Denzin, 1978). Triangulation can be done in two primary ways: “within-method” – which uses multiple techniques within a single method (qualitative or quantitative) and “between-method” – which uses multiple methods or “mixed methods” as a vehicle for cross validation. “Within-method” provides superior reliability or internal consistency, while “between-method” provides superior convergent external validity. Additionally, Jick (1979) recommends that “between-method” be used as a triangulation mechanism when “a more complete, holistic, and contextual portrayal of the unit(s) under study” is desired. Since the research goal of this dissertation is to build a holistic and contextual description of the phenomenon of organizational agility with high reliability and superior convergent validity, a decision was made to use “between-method” or mixed-methods as the research method of choice for this dissertation.
Based on Creswell et al. (2003), it was decided to use a _sequential studies_ design, where the qualitative and quantitative phases are separate and sequential, rather than a _parallel or concurrent studies_ design, where qualitative and quantitative phases are conducted at the same time. Specifically, it was decided to utilize a _sequential exploratory_ design with initial qualitative research followed by subsequent quantitative research, due to two key reasons. First, _sequential exploratory_ studies are appropriate when the primary focus of the design is to explore a phenomenon (Morgan, 1998), which aligned well with the goal of this dissertation of exploring the phenomenon of organizational agility in the context of enterprise systems. Second, such a design structure enabled data collected from the _qualitative_ research part of the dissertation to be integrated into theory generation and hypotheses validation for the _quantitative_ research parts e.g. Part 2 qualitative research was chronologically completed first. Part 1 and Part 3 quantitative research were _sequentially_ completed subsequently. Part 2 _qualitative_ research provided _exploratory_ insights that organizations which had enterprise systems “*embedded within their DNA*” seemed subjectively more adept at organizational agility. This gave rise to the theorizing and hypotheses validation in Part 1 _quantitative_ research that enterprise systems _usage_ and _levels of assimilation_ might be the appropriate theoretical frameworks for analyzing the research question on organizational _impact_. Similarly, Part 2 _qualitative_ research also provided _exploratory_ insights that in dealing with the challenges of organizational agility and business processes in enterprise systems, organizations were significantly focused on knowledge collaboration between IT and business units. This gave rise to the corresponding theorizing and hypotheses validation in Part 3 _quantitative_ research, that IT competence in business and business competence
in IT might be the appropriate theoretical constructs for analyzing the research question on organizational knowledge and competencies.

For data sampling approach, a mix of purposive and probability sampling was utilized (Teddle & Yu, 2007), with a sequential use of purposive and probability sampling strategies for qualitative and quantitative phases respectively. Purposive sampling in the qualitative phase allowed selection of specific cases of organizations at different stages of post-implementation of enterprise systems as well as different levels of dynamism in markets. On the other hand, probability sampling in the quantitative phase allowed wide range of cases to be selected to be representative of the population, for maximizing generalizability.

**Structure of Remaining Chapters**

The structure of the remaining chapters in this dissertation is as follows. Chapter 2 covers Part 1 research, which addresses the research question of the organizational impact of enterprise systems on agility. It is written in the structure of a complete stand-alone research paper suitable for publication in a research journal. Chapter 3 covers Part 2 research, which addresses the research question of the organizational processes by which organizations reconcile changing business needs driven by organizational agility, with enterprise systems. It too is written in the structure of a complete stand-alone research paper. Chapter 4 covers Part 3 research, which addresses the research question

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1 Since Chapters 2, 3 and 4 are all structured as standalone research papers based on common underlying research design, theoretical frameworks and related results, there may be some overlap in content within the three chapters (e.g. ‘Research Design and Methods’ section) as well as with other dissertation chapters (e.g. with Chapters 1 and 5).
of the effects of organizational *knowledge* and *competencies* on the impact of enterprise systems on organizational agility. Similar to Chapter 3 and 4, it is also structured as a stand-alone research paper. Finally, Chapter 5 ends with a conclusion, by summarizing the major research findings from all three research parts, discussing the contributions to theory and practice of this dissertation, as well as covering the overall limitations and future directions for study.
CHAPTER 2 - PART 1 RESEARCH

IS IMPLEMENTING ERP LIKE POURING CONCRETE INTO A COMPANY?
IMPACT OF ENTERPRISE SYSTEMS ON ORGANIZATIONAL AGILITY

Abstract

Literature is divided on whether enterprise systems promote or hinder organizational agility. There is also anecdotal evidence to support both sides of the argument. To the best of our knowledge, however, this paradox has never been rigorously theoretically analyzed nor empirically investigated. This paper seeks to address this paradox by leveraging upon innovation assimilation literature and capabilities based and knowledge based views of organizations. We propose a theoretical framework of the effects of ERP assimilation - potentially either positive or negative- on organizational agility. We also theorize that the speed of systems development capabilities, as exemplified by the dynamic capability of systems agility, not only has a direct effect on organizational agility, but also moderates the effect of assimilation levels of ERP on agility, so that it acts either as an amplifier or a brake on the positive or negative effects of assimilation, respectively. We validate the proposed framework by conducting a cross sectorial survey across 215 SAP user organizations to detect the impact of their systems

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on organizational agility. We also analyze the effect of systemic agility on whether such impact is amplified, as well as the presence of direct effects. The results validate our key theoretical claims: higher ERP assimilation levels positively influence organizational agility. Moreover, systems agility acts as a powerful and critical enabler by amplifying the positive impact of ERP assimilation level on organization agility, in addition to having a strong direct effect. We explain the presence of the paradox that earlier studies have not controlled for ERP assimilation levels or the level of system agility. The findings promote the view that organizations can achieve dexterity in both efficiency and agility, through their enterprise systems.

**Key words:** Enterprise systems, ERP, organizational agility, systems agility, innovation, assimilation, dynamic capabilities
Introduction

Over the last two decades, enterprises have faced increasingly turbulent competitive environments. Recent research indicates that in the last decade these competitive dynamics have only accelerated (McAfee & Brynjolfsson, 2008). During the same period enterprises have widely invested in enterprise-wide systems like enterprise resource planning (ERP) solutions, to manage better their operations. In less than a decade since the early 1990s, 76% of manufacturers, 35% of insurance and health care companies, 24% of Federal Government agencies and 60% of the U.S. Fortune 1000 companies have adopted an ERP system (Stedman, 1999; Stein, 1999). Currently SAP (the largest ERP vendor in the world by revenues) claims that “70% of the world economy’s transactions touch an SAP system in some way, shape or form” (SAP announcement).

The literature is, however, divided whether widespread utilization of ERP systems promotes or hinders organizational agility. One body of literature argues that complex and organization wide IT systems like enterprise systems enable an organization to rapidly sense changing business needs and respond via quick adaptations to business processes (Anderson et al., 2003; Davenport et al., 2005; Sambamurthy et al., 2003). Ergo, these systems promote organizational agility. Another body of literature, in contrast, posits that because enterprise systems assume tight integration and coupling between business processes and different parts of the business, it generates unprecedented complexity and inertia. This leads to rigidity and change avoidance, whereby widespread use of enterprise systems hinders organizational agility (Rettig, 2007). This idea is well
illustrated in an Economist article titled ‘Liquid Concrete’ (The Economist, Sep 13 2007), which summarized a practitioner’s view of ERP systems by stating that “implementing SAP [the leading enterprise system] is like pouring concrete into a company”.

To the best of our knowledge, the paradox between enterprise systems both promoting and hindering organizational agility has never been theoretically analyzed nor empirically addressed. This paper attempts to address this paradox by leveraging upon innovation assimilation literature and proposing a theoretical framework of the effects of ERP assimilation - that cover potentially both positive and negative effects- on organizational agility. We also theorize that the speed of systems development capabilities, as conveyed by the dynamic capability of systems agility, not only has a direct positive effect on organizational agility, but also moderates the potential positive or negative effects of ERP assimilation on agility. In other words, it acts either as an amplifier or a brake on both the positive and negative side of the effects of ERP assimilation.

We validate the proposed theoretical model by conducting a cross sectorial survey across 215 organizations that have implemented SAP system. The validation seeks to detect the impact of ERP assimilation on organizational agility, as well as the effects of systems agility on whether such impact occurs. The results demonstrate that higher ERP assimilation levels positively influence organizational agility. Moreover, systems agility forms a powerful and critical enabler, as it has a strong positive direct effect on organizational agility as well as it positively moderates the positive impact of ERP assimilation on organization agility. The concepts of ERP assimilation (in contrast to just the presence of ERP) and the concept of system agility thus play a key theoretical role in
explaining the paradox of enterprise systems both promoting and hindering organizational agility.

The remainder of the paper is structured as follows. First, we briefly attend to the literature on enterprise systems and organizational agility. Next, we leverage prior research by systematically developing a theoretical framework that organizes ERP assimilation, systems agility and organizational agility into a causal model, to explain either positive or negative effects of ERP assimilation on organizational agility. We also postulate the interaction effects between ERP assimilation and systems agility. We then report our empirical research and review the findings. We finally conclude with a reflection on the implications of the research in this paper for theory and practice of organizational agility.

**Literature Review and Hypotheses**

*Enterprise Systems*

*ERP (Enterprise Resource Planning) systems* typically are large-scale transaction processing software solutions that integrate and automate enterprise-wide organizational processes in the form of ‘best practices’ (Davenport, 1998). On the other hand, *enterprise systems* are a portfolio of information systems implemented enterprise-wide, which integrate transaction processing with data analysis, data reporting and data flow across enterprise-wide and cross-enterprise units, functions and processes. Typically enterprise systems *comprise* of core transactional systems like ERP systems, supplemented and potentially tightly integrated with additional applications like business intelligence (BI), customer relationship management (CRM), supplier relationship management (SRM),
etc. Since ERP systems typically form the *core foundation* of enterprise systems, the terms ‘ERP systems’ and ‘enterprise systems’ will be used interchangeably and synonymously in this paper.

ERP systems are characterized by three attributes, which distinguish them from earlier classes of administrative information systems:

1. ERP systems incorporate very large scale integration of diverse and disparate enterprise processes such as finance, sales, marketing, operations, manufacturing, warehousing, distribution, product development, human resources, etc. in one common database (Markus & Tanis, 2000).

2. ERP systems are real-time in nature, such that they enable the real-time propagation of “the same information almost instantaneously through one unified user interface” (Bingi et al., 1999), across almost all functions of the firm.

3. ERP systems are purchased or leased in most cases from a single software vendor. They are not built around the specific business processes of an individual organization (Sharma & Yetton, 2003). In contrast, they are designed around generic functional business models, which are considered to reflect ‘best industry practices’ (Wagner et al., 2006).

Because of these characteristics ERP systems are often considered transformational in nature.

**Organizational Agility**

Over the last two decades organizational agility has been studied across multiple disciplines including strategic management, operations, marketing and information
systems. Consequently, the definition of organizational agility has evolved leading to a lack of theoretical clarity (Schnackenberg et al., 2011). Three key characteristics distinguish organizational agility in the current discourse from other organizational properties:

First, organizational agility recognizes the speed of organizational change as exemplified by the idea of decision making speed (Judge & Miller, 1991), in ‘high-velocity’ environments (Eisenhardt, 1989). Second, organizational agility recognizes the ease of organizational change as exemplified by the constructs of flexibility (Bahrami, 1992) or strategic flexibility (Hayes & Pisano, 1994). Although constructs of flexibility and strategic flexibility often implicitly recognize speed as an element therein, their definitions focus more on the ease of change than the speed of change. Characteristics of both speed of change and ease of change have been studied in more detail by researchers that seek to identify antecedents to organizational agility, such as modularity (Sanchez & Mahoney, 1996), internal organizational structures leveraging upon contingent workforce and loose couplings (Matusik & Hill, 1998), external organizational structures supporting strategic alliances (Young-Ybarra & Wiersema, 1999), and increased product variety (Worren et al., 2002).³ The third key characteristic of organizational agility is the presence of sensing and responding mechanism, which is defined by Sambamurthy et al. (2003, p. 245), as “the ability to detect opportunities for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise”.

³ For a contrarian point of view see Raynor & Bower (2001).
For this paper, we will use the following definition of organizational agility (Tallon & Pinsonneault, 2011):

“(Organizational) agility (is) defined as the ability to detect and respond to opportunities and threats in the environment with ease, speed and dexterity” (Tallon & Pinsonneault, 2011, p. 464)

This definition not only emphasizes and highlights all the three characteristics of speed of change, ease of change and sensing/responding, but also adds a dimension of dexterity implying the need for organizations to achieve an appropriate balance amongst competing requirements.

Theory Development: Enterprise Systems and Organizational Agility

To articulate the impact of enterprise systems on organizational agility, it is not sufficient to simply consider the impact of the presence or absence of enterprise systems on organizational agility. The main reason is that the system must be used in order to have any effects on organizational behaviors qualified as being agile. Just attending to the presence of the system would therefore not incorporate the theorizing of the complex interactions between the three characteristics of enterprise systems as a class of information systems – deep and large-scale process integration, real-time data integration, and “best practices” process design. These effects come to bear on an organization’s ability to be agile i.e. increasing speed, flexibility and sense and response, only when the systems are used over time more extensively.

Our analysis starts with an assumption that ERP systems need to be considered to be a complex technology driven organizational innovation. Accordingly, theories of
technology innovation are relevant for our analysis, as the key effect of technology innovations on organizations is determined by the extent to which the innovation gets assimilated within the organization (Armstrong & Sambamurthy, 1999; Zmud & Apple, 1992). We accordingly ground our analysis of the effects of ERP on the concept of innovation assimilation. Specifically, we define ERP assimilation based on Purvis et al. (2001) as “the extent to which the use of technology (ERP) diffuses across the organizational projects or work processes and becomes routinized in the activities of those projects and processes”. We specifically surmise that the extent of assimilation is the key cause of effects of enterprise systems on organizational agility.

We will use the construct of ERP assimilation along its dimensions of diffusion and routinization in conjunction with research on knowledge-based (Grant, 1996; Spender, 1996), capabilities-based (Collis, 1994; Eisenhardt & Martin, 2000; Teece et al., 1997), resource-based (Barney, 1991; Penrose, 1959) and risk-based (Baird & Thomas, 1985; Bromiley, 1991) views on organization and strategy. Using these theories we will next build two competing perspectives articulating how ERP assimilation can have either a positive effect or a negative effect on organizational agility.

**ERP Assimilation Promotes Organizational Agility**

By definition, increased ERP assimilation will result in increased diffusion and increased routinization of ERP systems in the organization. From a knowledge based view, increased diffusion of ERP systems increases knowledge “reach” in an organization through large scale integration across multiple information sources within the organization (e.g. one common integrated database for customers, vendors, products, etc.)
across business units) as well as integration with databases outside the organization (e.g. partner databases, point-of-sale databases, etc). At the same time, increased routinization of ERP systems enhances knowledge "richness" by encouraging managers to routinely use information that is high quality, real-time as well as highly customizable (Overby et al., 2006). Increased knowledge "reach" and "richness" in turn increases the digital options available to a firm, resulting in increased organizational agility (Sambamurthy et al., 2003).

From a capabilities perspective, an increase in both diffusion as well as routinization of ERP systems enhances sensing capability in organizations through dynamic IT capabilities for "managing by wire" i.e. management with processes enhanced by capabilities to speedily sense and process volumes of environmental information, which far exceed the processing capability and capacity of human beings (Haeckel & Nolan, 1993). Such increased sensing capabilities result in increased agility in more turbulent market environments.

From a resource-based view, due to ERP systems being highly customizable, configurable, modular and having an integrated design, an increase in both diffusion as well as routinization of ERP systems allow business processes within an organization to be widely and routinely reconfigured to support a wider range of alternative resources (e.g. new material in a component of a bill of material (BOM) of a product), while at the same time lowering the cost and time of switching such resources, vis-à-vis organizations without ERP systems. This results in enhanced resource flexibility, which increases organizational agility (Sanchez, 1995).
Finally, from a risk-based view, dynamic markets require managerial willingness to redefine organizational strategies, which varies inversely with perceived risk associated with change (Baird & Thomas, 1985). Perceived risk in turbulent environments can be reduced when managers can obtain current information about how customers are responding to an organization’s product as well as competitive products (Eisenhardt, 1990). Increased diffusion and routinization of ERP systems increases wide and routine use of information provided by enterprise system components such as business intelligence (BI) and customer relationship management (CRM), to obtain richer and better product or customer information respectively. This helps resolve market uncertainties more quickly and accurately, leading to lowered perceived risks in support of increased agility (Sanchez, 1995).

**ERP Assimilation Hinders Organizational Agility**

In contrast, literature from knowledge-based views also suggests that knowledge sharing enabled by increased diffusion and routinization of ERP systems may lead to decreased organizational agility, by reinforcing positions held by executives that come from what has worked in the past, thus creating a “competency-trap” for the future when dynamic market changes may necessitate unanticipated and new adaptive changes and corresponding new knowledge (Christensen, 1997; Eisenhardt & Martin, 2000).

Similarly from a capabilities perspective, an increase in ERP assimilation may lead to increased diffusion and routinization of “best-practice” processes around which ERP systems are designed. This may lead to organizations into a corresponding “capabilities-trap” by potentially reducing the ability to develop new capabilities based
on new processes and new knowledge (Galliers, 2007), resulting in decreased organizational agility.

From a resource-based perspective, based on high implementation and maintenance costs, increased diffusion and routinization of ERP systems may lead to IT executives being more inclined to utilize enterprise systems to extract short-term value, rather than to use such resources to explore new opportunities with longer-term returns (Gupta et al., 2006). Such reluctance to leverage existing resources to alternate usage may result in lower organizational agility.

Finally, from a risk-based view, increased diffusion and routinization of ERP systems results in tighter integration and coupling between business processes. Such tight integration creates additional complexity. Increased complexity may lead to increased rigidity and correspondingly higher risk, which may lead to lower organizational agility (Goodhue et al., 2009; Rettig, 2007).

Appendix A synthesizes and summarizes both of the above competing perspectives. In summary, the two competing theoretical frameworks synthesized from literature offer two conflicting predictions on the relationship between ERP assimilation and organizational agility, giving rise to a paradoxical tension between enterprise systems both helping and hindering agility. Although, independent and exclusive effects of positive and negative influences of ERP assimilation on agility may exist, based on the opposing theory streams above, the key to addressing this paradoxical tension is in understanding the net simultaneous effects of both positive and negative influences of ERP assimilation on organizational agility. Hence we propose the following two competing hypotheses:
Hypothesis 1: ERP assimilation has a net positive impact on organizational agility

Hypothesis 2: ERP assimilation has a net negative impact on organizational agility

Direct and Moderating Effect of Systems Agility

To understand the potentially paradoxical impacts of ERP assimilation on organizational agility is to unearth the conditions under which the impact can go either way. Literature from dynamic capabilities indicates that in response to environmental changes, organizations may need to change their business processes and product strategies (Hayes & Pisano, 1994; Sanchez & Mahoney, 1996). As a result, organizations would need systems development capabilities to make changes to the information systems in the organization, to closely match desired processes in response to market turbulence. Although literature in strategic management theorizes about the presence or absence of such system development capabilities, it generally stops short in delving into the speed of such system development capabilities (Sanchez, 1995). At the same time, although literature in agile systems development extensively theorizes about the speed of system development capabilities, it generally does not link it back to organizational agility (Cockburn, 2001; Vidgen & Wang, 2009).

We next combine these two insights from separate literatures to theorize that the speed of such system development capabilities will have an effect on organizational agility. We use the dynamic capability of systems agility, defined as “the organizational
ability to successfully and swiftly change its information systems” (Davis, 2009) as a measure of this speed of system development capabilities. It is to be noted from the definition of systems agility that it implicitly encompasses swift and successful changes to all information systems. Hence this dynamic capability of systems agility is not limited to only enterprise systems. The higher the systems agility capability in an organization, the higher would be the swiftness and success of changes to information systems in the organization. Such higher swiftness and success of information systems change would then increase the speed at which supported business processes and product strategies could change in response to dynamic markets, resulting in higher organizational agility. Hence, we propose the following hypothesis:

**Hypothesis 3: Systems agility positively impacts organizational agility**

By definition, two of the key effects of ERP assimilation are diffusion and routinization of enterprise systems in the organization, which in turn influence the levels of organizational agility. Diffusion levels can be increased through two mechanisms - increased unit scope diffusion by which existing functional modules of the ERP systems are rolled out across additional business units in the organization, as well as increased functional scope diffusion by which additional functional modules are rolled out in existing business unit. Since both, unit scope diffusion and functional scope diffusion require changes to the ERP system, and higher systems agility capability will increase the swiftness and success of such changes to the ERP system, it implies that higher systems agility will increase the levels of ERP diffusion and correspondingly influence the levels
of organization agility. At the same time, higher *routinization levels* of ERP systems across the processes and projects of an organization requires sufficiently stable processes supported by systems, in the time interval *between* successive changes driven by dynamic markets. The stability period of processes can be increased by decreasing the time spent *within* that time interval, in implementing system changes in support of the process changes. This can be achieved with *swifter and more successful* changes, corresponding to higher systems agility. Thus, higher systems agility can increase the levels of ERP *routinization* and correspondingly influence the *levels* of organizational agility. Since systems agility can influence both *effects* of ERP assimilation *viz.* diffusion and *routinization* and correspondingly their influence on levels of organizational agility, it implies that systems agility moderates the influence of ERP assimilation on organizational agility.

Earlier theorizing on the impact of ERP assimilation on organizational agility provided two competing theoretical frameworks, along with corresponding hypotheses of both *positive* and *negative* effects of ERP assimilation on organizational agility. Hence, we apply the above discussion of the moderating effects of systems agility on organizational agility to formulate the effects of systems agility under both competing frameworks. If Hypothesis 1 is true, then higher systems agility will lead to an *amplifying* effect of the net *positive* effects of ERP assimilation on organization agility. On the other hand if Hypothesis H2 is true, then higher systems agility will lead to a *dampening* of the net *negative* effects of ERP assimilation on organization agility. Both of these scenarios lead us to the following two competing hypotheses on the moderating effects of systems agility, in the impact of ERP assimilation on organizational agility.
Hypothesis 4: Systems agility positively moderates (amplifies) the net positive impact of ERP assimilation on organizational agility.

Hypothesis 5: Systems agility negatively moderates (dampens) the net negative impact of ERP assimilation on organizational agility.

The resultant placement of ERP assimilation, organizational agility and systems agility in a nomological network, produces two competing conceptual models for the research in this paper, as show in Figures 2 and 3.

FIGURE 2
Model A - ERP Assimilation Net Positively Impacts Organizational Agility
Research Design and Methods

To validate our hypotheses, we followed a socio-metric quantitative approach by conducting a survey on postulated impacts of ERP assimilation and systems agility on organizational agility. The unit of analysis in this study is a strategic business unit. We felt that this was the most appropriate granular level to obtain valid insights of ERP impacts.

Operationalization of Constructs

The scales for most constructs were adapted from existing instruments (Davis, 2009; Sambamurthy et al., 2007). Necessary additional revisions were done whenever needed given the context of the study.
Dependent Variable: Organizational Agility

We used the 18-item instrument from Sambamurthy et al. (2007) for measuring organizational agility. It is based on the framework of entrepreneurial agility and adaptive agility of Bharadwaj & Sambamurthy (2005) and was adapted to ensure that the unit of analysis was at a business unit level. Entrepreneurial agility was measured along the dimensions of proactiveness (Miller & Friesen, 1983; Ramanujam & Venkatraman, 1987), preemptiveness (MacMillan, 1983; Sethi & King, 1994) and radical innovation (Miller & Friesen, 1983; Zahra & Covin, 1995). Adaptive agility was measured along the dimensions of reactiveness (Hult et al., 2005; Tracey et al., 1999), resilience (Mallak, 1998; Sheffi & Rice Jr., 2005) and incremental innovation (Skaggs & Huffman, 2003; Subramaniam & Youndt, 2005).

Independent Variable: ERP Assimilation

We leveraged the instrument from Liang et al. (2007) which measured ERP assimilation along dimensions of volume, diversity and depth from Zmud & Massetti (1996). Although these dimensions and their associated items from Liang et al. (2007) address one element in the definition of assimilation viz. diffusion, we felt that they do not adequately address the other equally critical component of routinization in the definition of assimilation. Hence we consulted with Goodhue (see e.g. Goodhue et al., 2009) to develop an updated scale for measuring ERP assimilation along the three dimensions of diffusion, diversity of routinization and depth of routinization. Diffusion was measured on a 15-point scale by gathering objective input on the number of functional modules of the enterprise system implemented in the business unit. Diversity
of routinization was measured by gathering input on usage of each of the fifteen functional modules in operational, management and decision-making routines of the business unit. The final score was computed on a 5-point scale as a weighted average score across all functional modules, with twice the weightage for management and decision-making routines as compared to the baseline operational routines. Based on qualitative research from Kharabe (2012:2), depth of routinization was measured using a nine item scale, as a measure of the extent to which enterprise systems were ‘embedded in the DNA of the business unit’.

Moderating Variable: Systems Agility

We adapted the instrument from Davis (2009) to measure systems agility with a four item scale, with appropriate changes to ensure that unit of analysis was at business unit level.

Control Variables

We controlled for the following four variables, specific to the business unit, because of their potential impact on organizational agility as suggested by extant literature (Liang et al., 2007; Lu & Ramamurthy, 2011; Tallon & Pinsonneault, 2011).

Industry type. This was measured in categories of Consumer Products, Industrial Products, Services, Government/Non-profit and Others.

Size: Revenues. This was measured in mutually exclusive intervals of <$300M, <$1B, <$5B, <$10B and >$10B.

Size: Employees. This was measured in mutually exclusive intervals of 1-499; 500-1,999; 2,000-4,999 and 5,000+ employees.
**Age.** This was defined as the number of years since the founding of the business unit and was measured in mutually exclusive intervals of 0-4; 5-9; 10-19; 20-49 and 50+ years.

**Instrument Development**

As far as possible, we used existing instruments with good established psychometric properties to ensure measurement reliability and validity. In scale development and contextualization we followed the suggestions from DeVellis (2003). Since the items for at least one key construct in this research were not adapted from existing instruments, a two-step process was followed to ensure validity and reliability of these modified and self-developed items. First, the items were distributed to three well-know management and IS researchers and a PhD student, all of whom had expertise in the specific research area of this paper. The items were updated based on their feedback on face validity and construct validity of the instrument. Second, a pilot survey of the instrument was conducted with 50 respondents in one large publicly traded $3 billion organization in the US. The pilot was a cross-sectional survey with respondents identified across four business units and in positions of executive responsibility, as well as having knowledge of both business and IT aspects of their business unit. Exploratory factor analysis (EFA) was done on the pilot data and single factor loadings for each construct were found to be acceptable. Reliability analysis based on Cronbach’s alpha revealed that all constructs had acceptable values (>0.70), except resilience (0.7) and reactiveness (0.58). Based on subsequent analysis of inter-item correlation matrix, items of resi3 and reac3 were reworded to improve reliability. In addition, based on feedback from pilot respondents on the length of the survey, some constructs not core to the research of this
paper (project management agility, IT competence in IS, social capital) were dropped. Other than control variables and objective items, the finalized instrument had all scales defined as seven-point Likert scales and is included in Appendix B.

**Data Collection**

The finalized instrument was sent out as a cross-sectional web-survey to approximately 2000 organizations in the US, who have all implemented SAP ERP solution. SAP is the largest vendor of ERP solutions in the world. All of the organizations were identified through their membership in a US-based non-profit association of companies in US, who have implemented SAP ERP. The survey respondents in the organizations were targeted from a pool of both business and IT executives. Respondents were assured of complete confidentiality and did not receive any remuneration for their participation. The link to the web-survey was emailed by the user association to the organizations. A follow-up email was sent two weeks after the initial email, as a reminder. After exclusion of cases with missing data, we had a final sample size of 215 cases. Since the link to the web-survey was emailed by a trade group to the organizations, it was not possible to directly contact the organizations to measure non-response bias. However, emails received by the user association from the non-respondents indicated that the conference travels as well as organizational policies against participation were the key reasons for not responding. Characteristics of the respondents are provided in Table 2.
TABLE 2
Respondent Characteristics

**Business Unit – Industry**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Products</td>
<td>95</td>
<td>44%</td>
</tr>
<tr>
<td>Industrial Products</td>
<td>39</td>
<td>18%</td>
</tr>
<tr>
<td>Services</td>
<td>45</td>
<td>21%</td>
</tr>
<tr>
<td>Govt/Non-profit</td>
<td>10</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>25</td>
<td>12%</td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Business Unit – Employees**

<table>
<thead>
<tr>
<th>Employee Size</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-499</td>
<td>21</td>
<td>10%</td>
</tr>
<tr>
<td>500-1999</td>
<td>24</td>
<td>11%</td>
</tr>
<tr>
<td>2000-4999</td>
<td>30</td>
<td>14%</td>
</tr>
<tr>
<td>5000-9999</td>
<td>68</td>
<td>32%</td>
</tr>
<tr>
<td>10,000+</td>
<td>73</td>
<td>34%</td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Business Unit – Revenues**

<table>
<thead>
<tr>
<th>Revenue Size</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;$300 million</td>
<td>29</td>
<td>13%</td>
</tr>
<tr>
<td>&lt;$1 billion</td>
<td>30</td>
<td>14%</td>
</tr>
<tr>
<td>&lt;$5 billion</td>
<td>94</td>
<td>44%</td>
</tr>
<tr>
<td>&lt;$10 billion</td>
<td>22</td>
<td>10%</td>
</tr>
<tr>
<td>$10 billion+</td>
<td>40</td>
<td>19%</td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>100%</td>
</tr>
</tbody>
</table>
### Business Unit – Age

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4 years</td>
<td>8</td>
<td>4%</td>
</tr>
<tr>
<td>5-9 years</td>
<td>19</td>
<td>9%</td>
</tr>
<tr>
<td>10-19 years</td>
<td>31</td>
<td>15%</td>
</tr>
<tr>
<td>20-49 years</td>
<td>54</td>
<td>25%</td>
</tr>
<tr>
<td>50+ years</td>
<td>102</td>
<td>47%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>215</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**Measurement Model**

We used SPSS for univariate and multivariate analysis of the items, to ensure that it was appropriate for subsequent factor analysis. Normality tests based on skewness and kurtosis statistics showed that normality was within normal limits. Hence no transformation efforts were pursued. Additionally, visual inspection for normality, skewness and kurtosis using histogram, Q-Q plot and box-plot for each item confirmed that normality, skewness and kurtosis seemed within reasonable limits. Similarly, the data was assessed for multicollinearity, homoscedasticity and outliers, all of which were within limits. Appropriateness for factor analysis was assessed by examining Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (excellent at 0.913) and Bartlett’s test statistic for sphericity, which was significant at the 0.001 level.

An exploratory factor analysis (EFA) using principal axis factoring with Promax rotation resulted in eight factors, with each item loading on its factor with a value greater than 0.4 and all cross-load differences were greater than 0.2. The total variance explained by these eight factors was 68.8%. Even though the number of factors in EFA was in line with
the number of factors from the theoretical model, it was noticed that the sub-construct of preemptiveness (pree) loaded with the sub-construct of proactiveness (proc), within the construct of organizational agility (oa), while items1-3 within the construct of ERP assimilation (erpa) loaded as a separate factor. It was noted for future analysis that preemptiveness could have issues of discriminant validity. No items or sub-constructs were dropped for subsequent CFA. It was decided to start with full measurement model (based on theory) without any deletions, but keeping in mind the above observations.

Confirmatory Factor Analysis (CFA) was carried out by incorporating all the eight constructs and the associated items. Through an iterative process, appropriate error covariance relationships were added as well as items deleted (Byrne, 2009). Three items (inci3, sar4, resi2) were dropped from the CFA model, leaving a total of 30 items in the model. The overall model fit for the final CFA model was good (CMIN/DF = 1.641, CFI = .954, SRMR = 0.0521 and RMSEA = .055 (LO = .047, HI = .062, PCLOSE = .157)) (Byrne, 2009)

For all constructs, both Cronbach’s alpha and composite reliability was greater than the threshold of 0.7, thus confirming the theorized construct structure as well as validating that the corrections made for reliability improvement during pilot survey were relevant. All constructs showed excellent convergent validity with CR > AVE and AVE > 0.5 (Fornell & Larcker, 1981). All constructs other than preemptiveness showed high discriminant validity with MSV < AVE and ASV < AVE. For preemptiveness, ASV < AVE but MSV was 0.005 higher than AVE and hence it was considered to have acceptable discriminant validity. Table 3 shows reliability and validity of final constructs. The inter-factor correlations for the final constructs are included in Appendix C.


### TABLE 3

Reliability and Validity of Constructs

<table>
<thead>
<tr>
<th>Construct</th>
<th>Sub-construct</th>
<th>CR</th>
<th>AVE</th>
<th>MSV</th>
<th>ASV</th>
<th>Cronbach's Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational Agility</td>
<td>Proactiveness</td>
<td>0.935</td>
<td>0.828</td>
<td>0.630</td>
<td>0.299</td>
<td>0.899</td>
</tr>
<tr>
<td></td>
<td>Preemptiveness</td>
<td>0.832</td>
<td>0.625</td>
<td>0.630</td>
<td>0.320</td>
<td>0.824</td>
</tr>
<tr>
<td></td>
<td>Radical Innovation</td>
<td>0.888</td>
<td>0.727</td>
<td>0.526</td>
<td>0.307</td>
<td>0.881</td>
</tr>
<tr>
<td></td>
<td>Reactiveness</td>
<td>0.903</td>
<td>0.756</td>
<td>0.531</td>
<td>0.401</td>
<td>0.898</td>
</tr>
<tr>
<td></td>
<td>Resilience</td>
<td>0.715</td>
<td>0.561</td>
<td>0.372</td>
<td>0.224</td>
<td>0.740</td>
</tr>
<tr>
<td>ERP Assimilation</td>
<td>Incremental Innovation</td>
<td>0.935</td>
<td>0.877</td>
<td>0.372</td>
<td>0.251</td>
<td>0.900</td>
</tr>
<tr>
<td>Systems Agility</td>
<td></td>
<td>0.910</td>
<td>0.513</td>
<td>0.375</td>
<td>0.219</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.924</td>
<td>0.802</td>
<td>0.436</td>
<td>0.250</td>
<td>0.920</td>
</tr>
</tbody>
</table>

Since the data was collected using a single method from a single source, the possibility of having introduced common method bias cannot be eliminated. Harman’s single-factor test (Podsakoff et al., 2003) showed that the first factor explained 40% of total variance (< 50%). A common marker analysis was carried out showing the presence of 20% common method variance. This is within acceptable threshold for IS research (Malhotra et al., 2006). A nested model comparison between the final measurement model and the common marker model was not significant (p=0.463), indicating that common method effect was not significant for the overall measurement model.

**Structural Analyses**

A structural equation model (SEM) was built in AMOS, as per the causal model in Figures 2 and 3. The final trimmed model was created through reviewing modification...
indices, adding covariance paths where theoretically justified, and trimming insignificant paths when necessary (Byrne, 2009). The final model had a good fit: CMIN/DF = 2.69, CFI = 0.956, SRMR = 0.0507, RMSEA = 0.089, (LO = 0.069, HI = 0.11, PCLOSE = 0.001).

Findings

The final structural equation model shows that ERP assimilation (β=0.146) is significant as a determinant of organizational agility (p = 0.01). Since β is positive, it implies that ERP assimilation net positively influences organizational agility. Hence Hypothesis 1 is supported and correspondingly Hypothesis 2 is rejected.

Systems agility (β=0.437) was also found to be significant as a determinant of organizational agility at the p < 0.001 level. Since β is positive, Hypothesis 3 is supported.

The interaction term of systems agility and ERP assimilation (β=0.057) was found to be significant at the p < 0.1 level. This implies that systems agility moderates the effect of ERP assimilation on organizational agility. Combined with the fact that Hypothesis 1 with net positive effects of ERP assimilation was supported implies that Hypothesis 4 is supported while Hypothesis 5 is not supported.

Overall, Model A with net positive effects for ERP assimilation on organizational agility was supported by the findings and hence Model B with net negative effects of ERP assimilation on organizational agility was rejected. Model A explained 49.6% of the variance of organizational agility. None of the control variables were found
to be significant in determining organizational agility. The results are summarized in Table 4.

TABLE 4
Results of Hypothesized Relationships

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Supported?</th>
<th>Estimate</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>ERP assimilation has a net positive impact on organizational agility</em></td>
<td>Yes</td>
<td>0.146</td>
<td>0.003</td>
</tr>
<tr>
<td>2. <em>ERP assimilation has a net negative impact on organizational agility</em></td>
<td>No</td>
<td>n.a.</td>
<td>n.s.</td>
</tr>
<tr>
<td>3. <em>Systems agility positively impacts organizational agility</em></td>
<td>Yes</td>
<td>0.437***</td>
<td></td>
</tr>
<tr>
<td>4. <em>Systems agility positively moderates (amplifies) the net positive impact of ERP assimilation on organizational agility.</em></td>
<td>Yes</td>
<td>0.057</td>
<td>0.077</td>
</tr>
<tr>
<td>5. <em>Systems agility negatively moderates (dampens) the net negative impact of ERP assimilation on organizational agility.</em></td>
<td>No</td>
<td>n.a.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Support for Hypothesis 1 implies that a significant linear relationship exists between ERP assimilation and organizational agility (though the effect size is not that large). Support for Hypothesis 3 implies that a significant linear relationship exists between system agility and organizational agility (and effect size is medium). Finally, support for Hypothesis 4 implies that with systems agility moderating the relationship between ERP assimilation and organizational agility, systems agility and ERP assimilation interact with each other causing a differential impact on the dependent
variable of organizational agility. Hence, we would expect to see a change in the slope and intercept of the linear relationship between ERP assimilation and organizational agility for different values of systems agility. In order to visualize this change, an interaction plot was graphed as shown in Figure 4.

**FIGURE 4**

Interaction Plot of ERP Assimilation and Systems Agility

The results from the interaction plot are interesting and illuminating. When an organization has low capability of systems agility, organizational agility is almost flat with increases in ERP assimilation i.e. higher ERP assimilation does not result in significantly higher organizational agility. This can assist in explaining part of the paradox, especially in practitioner literature, of enterprise systems perceptually not helping organizational agility. At the same time, for organizations which possess high
capabilities of systems agility, organizational agility increases with increase in ERP assimilation i.e. systems agility has an amplifying effect in the impact of ERP assimilation on organizational agility (on top of those achieved by system agility directly). This can again help explain the other part of the paradox, especially in scholarly literature, of enterprise systems helping organizational agility i.e. organizations need complementary resources that are leveraged through system agility. In addition, even for low levels of ERP assimilation, the above interaction plot shows that higher levels of systems agility result in higher organizational agility. Systems agility seems to be the key organizational ingredient, which acts as a catalyst in enabling the positive impact of enterprise systems on organizational agility.

**Discussion**

Prior research in information systems has shown that enterprise systems improve productivity, efficiency, effectiveness and financial performance in organizations (Goodhue et al., 2009). The primary focus of the research in this paper was to extend this understanding to the impact of enterprise systems on organizational agility- specifically in resolving the paradox of whether enterprise systems promote or hinder organizational agility. In addition, we also wanted to understand the context in which enterprise systems may impact organizational agility. In order to achieve these objectives, we leveraged the framework of innovation assimilation to embed ERP assimilation, organizational agility and systems agility in a nomological network, with systems agility moderating the impact of ERP assimilation on organizational agility.
Our primary result shows that ERP assimilation overall *promotes* rather than hinders organizational agility, with a net positive relationship between ERP assimilation and organizational agility, independent of the level of systems agility in the organization. This supports our original theoretical positioning that *assimilation* of ERP based on the dimensions of *diffusion* and *routinization* is a fruitful framework to understand the impact of enterprise systems on organizational agility. Additionally, the result supports that *within* such an ERP assimilation model, existing theoretical frameworks based on resource-based, capabilities-based, knowledge-based and risk-based views can explain a net positive connection between enterprise systems and organizational agility. It also supports prior research in the literature (Davenport et al., 2005; Sambamurthy et al., 2003) that information systems, in general, provide capabilities which have a direct effect on organizational agility. The result extends this prior research to enterprise systems specifically, implying that the theoretical underpinnings justifying this relationship continue to be valid, even at the boundary line conditions exemplified by enterprise systems, as a class of information systems with extremely high levels of technology integration in terms of both *breadth* of process scope and *depth* of data integration. At the same time, the result forces us to revisit other contrasting claims in the literature that enterprise systems hinder organizational agility (Galliers, 2007; Rettig, 2007). Specifically, the claim that organizations will find it difficult to achieve *dexterity* between the *efficiency* and speed gains from tight and widespread integration in enterprise systems and the *agility* declines from their corresponding complexity, is laid to rest by this result. Maybe these studies observed the effects of enterprise systems during the early stages of assimilation.
Our research suggests that the dynamic capability of *systems agility* has a direct and a large measured effect on organizational agility. Hence it supports a) the dynamic capabilities view that market turbulence requires changes in business processes and product strategies which necessitates system development capabilities (Eisenhardt & Martin, 2000), as well as b) supports our extension on dynamic capabilities by validating our theorizing that the *speed* of such system development capabilities as exemplified by the dynamic capability of *systems agility* positively influences organizational agility.

Finally, our research shows that the dynamic capability of systems agility indeed positively and significantly moderates the impact of ERP assimilation on organizational agility. Not only does higher systems agility lead to higher organizational agility when ERP assimilation is higher, but even in organizations with low ERP assimilation, higher systems agility has a large amplifying effect on organizational agility. In a sense, systems agility functions as a catalyst or as a key enabler for unlocking the potential of ERP assimilation to make an organization agile. This is a significant result, for both theory as well as practice. From a theoretical perspective, our result extends on Tallon & Pinsonneault (2011) by providing empirical evidence that IT capabilities like systems agility provide digital options which can have a *moderating* effect on organizational agility, vis-à-vis the *mediating* or direct effects of digital options on organizational agility in the nomological network from Sambamurthy et al. (2003). From a practitioner’s perspective, our result highlights the importance of the development and sustainment of system oriented dynamic capabilities like systems agility in organizations, to ensure that the full value of innovations like enterprise systems can be accrued to the organization. In
contrast to Carr (2003), we can say that IT system capabilities still matter, while IT in itself may not matter.

Limitations

Some of the limitations and key assumptions for the research in this paper are as follows. The data collected were limited to organizations in the United States. Hence the findings may not be generalizable outside USA. The organizations selected for data collection have all implemented one specific ERP solution viz. SAP. Hence the findings may not be generalizable to organization with other ERP solutions and would need further study. In addition, newer versions of ERP systems offering Web services or cloud based services may change the configurability of ERP systems such that assimilation effects accrue earlier. To participate in data collection, organizations were randomly selected by a non-profit trade group in USA comprising of members who have implemented SAP. It is not known if the request from an association explicitly introduces any selection bias while identifying the organizations to participate in the survey. Since the link to the web-survey was emailed by a third-party non-profit association to the organizations directly, it is not possible to empirically measure or validate the presence of non-response bias or conduct wave tests to compare late or early respondents (Armstrong & Overton, 1977).

Implications for Practice and Future Research

Enterprise systems have increasingly become a key focus for IS practice with executives concerned by the high sunk costs in implementations and license fees (typically ranging together in the millions of dollars), perceived high failure rates even
well into post-implementation phase and high on-going maintenance costs. Such concern is all the more heightened due to a widely held practitioner perspective that enterprise systems introduce rigidity and hinder an organization’s ability to be agile. Our research addresses these concerns with the primary result that not only do enterprise systems not introduce rigidity in the organization, on the contrary they have a net positive and direct effect on organizational agility. Organizations can thus achieve dexterity in both efficiency and agility, through their enterprise systems.

In post-implementation or sustainment phase of enterprise systems in an organization, management may tend to focus on cost containment strategies, also known as ‘keep the lights on”, in their approach to information systems maintenance. Our results show that IS managers need to specifically focus on inculcating systems development dynamic capabilities in the organization, since the speed of such systems development capabilities not only has a direct effect on making the organization agile, but in addition it has an amplifying effect in enabling the role of enterprise systems to influence organizational agility in turbulent market environments.

In addition, C-level management needs to be aware that it is not sufficient to simply support implementation of enterprise-wide innovation technologies. Such an approach might improve efficiency and productivity in the organization, however in order to extract full value from their investments in such innovations, they also need to take an active leadership role in assimilation of such innovations in the organization, by ensuring that such innovations “diffuse across the organizational projects or work processes and become routinized in the activities of those projects and processes” (Purvis et al., 2001). In a sense, such enterprise-wide innovation technologies need to be embedded within the
**DNA of the organization**, since our results clearly show that higher the assimilation of enterprise systems in an organization, higher is the ability of the organization to be agile in the face of dynamic competitive pressures.

Our research indicates two areas for further research. First, our research extends on the dynamic capabilities view of organizational agility, with systems agility playing a singular role in the case of enterprise systems. Literature from dynamic capabilities indicates that organizational knowledge and competencies are foundational in the operationalization of dynamic capabilities, in both moderate and highly dynamic markets (Eisenhardt & Martin, 2000). Hence an important area of further research would be to understand the role of organizational knowledge and competencies within the nomological network developed in this paper. Second, the research in this paper can be replicated in international business as well as in organizations with multiple types of enterprise solutions, in order to make the results more generalizable and accurate. One direction we also plan to pursue is the effect of the configurations of modules on organizational agility and the influence of environmental turbulence.

We started this research with the prime objective of resolving the paradox of innovations like enterprise systems both promoting and hindering organizational agility, as well as understanding the context in which enterprise systems may impact organizational agility. The motivation for this quest was best summed up by the article on ERP systems in *The Economist* (Sep 13, 2007) which used the metaphor of “implementing ERP is like pouring concrete into a company”. Along our journey, we have realized that the above metaphor is not accurate. Perhaps an updated metaphor
might be “implementing ERP is like pouring high octane fuel into a company, as long as you catalyze that fuel with systems agility”.
Appendix A - Competing Perspectives on Impact of Enterprise Systems on Organizational Agility

<table>
<thead>
<tr>
<th>Knowledge-based</th>
<th>Enterprise Systems Promote Organizational Agility</th>
<th>Enterprise Systems Hinder Organizational Agility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Enterprise systems can support organizational agility by providing digital options, based on increased knowledge &quot;reach&quot; and &quot;richness&quot; in an organization (Sambamurthy et al., 2003)</td>
<td>Knowledge sharing enabled by enterprise systems may reinforce positions held by executives that come from what has worked in the past and may create a bottleneck for the future when dynamic market changes may necessitate unanticipated and new adaptive changes and corresponding new knowledge (Christensen, 1997; Eisenhardt &amp; Martin, 2000).</td>
</tr>
<tr>
<td></td>
<td>Enterprise systems enhance knowledge &quot;richness&quot; by providing information to managers that is not only high quality but also real-time as well as high customizable. Enterprise systems are well positioned to increase knowledge &quot;reach&quot; in an organization, through large scale integration across multiple information sources e.g. one common integrated database across all the processes in an organization supported by ERP such as customers, vendors, products, designs, finances, human resources, etc. as well as integration with databases outside the organization - partner databases through EDI, point-of-sale databases through the Internet, customer feedback through customer relationship management systems and product feedback through social networks (Overby et al., 2006)</td>
<td>It is primarily human beings who apply their meaning and their knowledge to information, in order to make sense of the data for any specific purpose (Weick, 1995). Information systems like ERP systems are argued to be simply data collecting, data processing and data integration devices. They still require human beings to apply their sense to data and convert it to information. Hence, such knowledge generally turns out to be not only tacit but also embedded within human beings. It also tends to be ‘sticky’, in the sense that it may be very difficult to transfer from human beings to systems (Szulanski, 1996).</td>
</tr>
<tr>
<td>Capabilities-based</td>
<td>Enterprise Systems Promote Organizational Agility</td>
<td>Enterprise Systems Hinder Organizational Agility</td>
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<tr>
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<tr>
<td>Enterprise systems provide enhanced sensing capability through dynamic IT capabilities for &quot;managing by wire&quot; i.e. management in turbulent environments with processes enhanced by capabilities to speedily sense and process volumes of information which far exceed the capability and capacity of human beings to process them (Haeckel &amp; Nolan, 1993)</td>
<td>Enterprise systems are designed around &quot;best-practice&quot; processes. By copying of &quot;best-practice&quot; processes, it improves efficiency but at the same time such “best-practices” may lead to organizations potentially reducing the ability to develop new capabilities based on new processes and new knowledge (Galliers, 2007)</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Resource-based</th>
<th>Enterprise Systems Promote Organizational Agility</th>
<th>Enterprise Systems Hinder Organizational Agility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise systems help organizational agility through increased resource flexibility. Resource flexibility can be increased by increasing the number of alternative uses to which a resource can be applied as well as lowering the costs and time required to switch to an alternate resource. ERP systems are a class of information technologies which due to their highly customizable, configurable, modular and integrated structure allow business processes within an organization to be reconfigured to support a range of alternative resources (e.g. new material in a component of a bill of material (BOM) of a product) while at the same time lowering the cost and time of switching such resources, vis-à-vis organizations without ERP systems (Sanchez, 1995)</td>
<td>Based on high implementation costs and low disposal values of enterprise systems, IT executives may be more inclined to utilize enterprise systems to deliver immediate value rather than to use such resources to explore new opportunities with risky immediate returns (Gupta et al., 2006)</td>
<td></td>
</tr>
<tr>
<td>High-level Integration</td>
<td>Enterprise Systems Promote Organizational Agility</td>
<td>Enterprise Systems Hinder Organizational Agility</td>
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<td>-----------------------</td>
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<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Since enterprise systems are designed around a single database with a wide range of business processes integrated in them ranging from design, development, sales, distribution, production and finance, flexibility is extended across the organization when compared to organizations with non-integrated information technologies, for implementing rapid and widespread data flow (e.g. rapid propagation of the updated BOM with the new material through integrated processes in ERP of purchasing, pricing, manufacturing, etc) (Markus &amp; Tanis, 2000)</td>
<td>Concept of single, monolithic system may be a myth. Different business units may purchase different ERP systems or may acquire multiple systems through mergers and acquisitions. Business units may end up with multiple instances of same or different enterprise systems leading to a complex landscape which can impede agility (Rettig, 2007)</td>
<td></td>
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<tr>
<td>Customization</td>
<td>In response to turbulent environments, organizations often need to change their business processes and product strategies. Enterprise systems allow rapid prototyping of such changes through the process of customization e.g. changes in customer and vendor relationships as well as pricing changes in response to environmental changes. Such customizations enable alignment between business processes and enterprise systems (Wagner et al., 2006), resulting in enhanced responding capabilities and higher agility for the organization.</td>
<td>&quot;As enterprise software becomes increasingly comprehensive and complex, the costs and risks involved in customizing it increase as well. No single person within an organization could possibly know how a change in one part of the software will affect its functioning elsewhere.&quot; (Rettig, 2007). Higher customization may lead to higher complexity, which may lead to decreased agility.</td>
</tr>
<tr>
<td>Enterprise Systems Promote Organizational Agility</td>
<td>Enterprise Systems Hinder Organizational Agility</td>
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<td>------------------------------------------------</td>
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<tr>
<td>Dynamic markets require managerial willingness to redefine organizational strategies which varies inversely with perceived risk associated with change (Baird &amp; Thomas, 1985). Perceived risk in turbulent environments can be reduced when managers can obtain current information about how customers are responding to organization’s product as well as competitive products (Eisenhardt, 1990). Effective use by managers of integrated components of enterprise systems such as business intelligence (BI) and customer relationship management (CRM) to obtain such product or customer information respectively may help resolve market uncertainties quickly and accurately, leading to lowered perceived risks in support of increased agility (Sanchez, 1995)</td>
<td>Enterprise systems require tight integration and coupling between business processes. Such tight integration creates additional complexity. Increased complexity may lead to increased rigidity and correspondingly higher risk, which may lead to enterprise systems hindering organizational agility (Goodhue et al., 2009; Rettig, 2007)</td>
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</tbody>
</table>
### Appendix B - Constructs and Items

<table>
<thead>
<tr>
<th>Construct (label)</th>
<th>Dimension (label)</th>
<th>Sub-Dimension (label)</th>
<th>Item</th>
</tr>
</thead>
</table>
| **Org. agility (oa)** | Entrepreneurial agility (ea) | Proactiveness (PROC) | PROC1. Anticipate new business opportunities  
PROC2. Seek new business opportunities  
PROC3. Seek novel approaches to future market needs |
| | | Preemptiveness (PREE) | PREE1. Be the first to market with new business approaches (or models)  
PREE2. Develop new standards and practices in the industry  
PREE3. Preempt imitators through marketing actions |
| | | Radical innovation (RADI) | RADI1. Seek high-risk projects with chances of high return  
RADI2. Support business experimentation despite uncertain returns  
RADI3. Commit resources to radical changes that can potentially transform markets and competition |
| | Adaptive agility (aa) | Reactiveness (REAC) | REAC1. Rapidly react to emerging opportunities in customer needs  
REAC2. Rapidly react to emerging opportunities in markets  
REAC3. Rapidly react to emerging opportunities in new products and services |
| | | Resilience (RESI) | RESI1. Rapidly respond to natural threats (e.g., natural disaster)  
RESI2. Rapidly respond to competitive threats (e.g., competitor’s price change and new marketing campaign)  
RESI3. Rapidly respond to operational threats (e.g., production disruption) |
| | Incremental innovation (INCI) | | INCI1. Adapt existing business models  
INCI2. Adapt existing business processes  
INCI3. Quickly adopt best practices used by others |
<table>
<thead>
<tr>
<th>Construct (label)</th>
<th>Dimension (label)</th>
<th>Sub-Dimension (label)</th>
<th>Item</th>
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</thead>
<tbody>
<tr>
<td>ERP Assimilation (erpa)</td>
<td>Diffusion (diff)</td>
<td></td>
<td>Which of the following modules of SAP ERP solution have been implemented for your business unit/division?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FI-CO (Financial Accounting/Controlling)</td>
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<td></td>
<td></td>
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<td>HR (Human Resource)</td>
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<td></td>
<td></td>
<td></td>
<td>SD (Sales and Distribution)</td>
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<td></td>
<td></td>
<td></td>
<td>MM (Materials Management)</td>
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<td></td>
<td></td>
<td></td>
<td>PP (Production Planning)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>PM (Plant Maintenance)</td>
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<td></td>
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<td></td>
<td>QM (Quality Management)</td>
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<td></td>
<td></td>
<td></td>
<td>BW (Business Warehousing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LIS (Logistics Information System)</td>
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<tr>
<td></td>
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<td></td>
<td>IS (Industry Solutions e.g. Retail, AFS)</td>
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<td></td>
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<td></td>
<td>CRM (Customer Relationship Management)</td>
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<td>PLM (Product Life Cycle Management)</td>
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<td></td>
<td>SCM (Supply Chain Management)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>SRM (Supplier Relationship Management)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>SEM (Strategic Enterprise Management)</td>
</tr>
<tr>
<td>Diversity of Routinization (r_di)</td>
<td></td>
<td></td>
<td>For those modules implemented, please also identify what they are used for in your business unit/division.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Used for Operations</td>
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<td></td>
<td></td>
<td></td>
<td>Used for Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Used for Decision-making</td>
</tr>
<tr>
<td>Construct (label)</td>
<td>Dimension (label)</td>
<td>Sub-Dimension (label)</td>
<td>Item</td>
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<tr>
<td>ERP Assimilation (erpa)</td>
<td>Depth of Routinization (r_de)</td>
<td></td>
<td>Item1 We expect the ERP system will provide future opportunities for improving the way we do business.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Item2 We see the ERP system as providing additional opportunities for improving the unit’s effectiveness.</td>
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<td></td>
<td>Item3 We see the ERP system not just as a replacement for our old systems but also as a new platform that can provide valuable new capabilities.</td>
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<td></td>
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<td>Item4 We actively look for new ways of using the ERP system to improve our effectiveness.</td>
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<td></td>
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<td></td>
<td>Item5 We encourage our people to further explore and learn the ERP system so that new ways of utilizing it can be found.</td>
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<td></td>
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<td></td>
<td>Item6 We devote resources to exploring the ERP system to find new ways to leverage its power.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Item7 We continue to find new ways of taking advantage of the ERP system to improve the way we do business.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Item8 We are still discovering new ways of using the ERP system to get business benefits.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Item9 The ERP continues to give us new opportunities to improve our effectiveness.</td>
</tr>
<tr>
<td>Construct (label)</td>
<td>Dimension (label)</td>
<td>Sub-Dimension (label)</td>
<td>Item</td>
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</tbody>
</table>
| Systems Agility  | Systems Agility (sar) | **SAR1** - We are successful in rapidly changing our information systems in response to changing business needs.  
**SAR2** - The information systems in place within our business unit enable our capability to make critical changes quickly in response to changing business needs  
**SAR3** - Within our business unit, we can quickly change our information systems in response to changing business needs  
**SAR4** - In general, our business unit's IT group can make needed system changes in a timely manner |
| Controls         | Industry (bu_industry) | Consumer Products, Industrial Products, Services, Govt/Non-Profit, Others |
|                  | Size- # employees(bu_employees) | 1-499; 500-1,999; 2,000-4,999; 5,000+ |
|                  | Size- revenues (bu_revenues) | <$300M, <$1B, <$5B, <$10B, >$10B |
|                  | Age – years since founding of this business unit (bu_age) | 0-4; 5-9; 10-19; 20-49,50+ |
# Appendix C - Inter-Factor Correlations

<table>
<thead>
<tr>
<th></th>
<th>ERP Assimilation</th>
<th>Proactiveness</th>
<th>Preemptiveness</th>
<th>Radical Innovation</th>
<th>Reactiveness</th>
<th>Resilience</th>
<th>Incremental Innovation</th>
<th>Systems Agility</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERP Assimilation</td>
<td>0.716</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Proactiveness</td>
<td>0.367</td>
<td>0.910</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Preemptiveness</td>
<td>0.331</td>
<td>0.794</td>
<td>0.791</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Radical Innovation</td>
<td>0.451</td>
<td>0.627</td>
<td>0.725</td>
<td>0.852</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Reactiveness</td>
<td>0.518</td>
<td>0.635</td>
<td>0.729</td>
<td>0.695</td>
<td>0.870</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Resilience</td>
<td>0.475</td>
<td>0.406</td>
<td>0.401</td>
<td>0.387</td>
<td>0.568</td>
<td>0.749</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incremental Innovation</td>
<td>0.462</td>
<td>0.463</td>
<td>0.378</td>
<td>0.435</td>
<td>0.600</td>
<td>0.610</td>
<td>0.937</td>
<td></td>
</tr>
<tr>
<td>Systems Agility</td>
<td>0.612</td>
<td>0.392</td>
<td>0.372</td>
<td>0.455</td>
<td>0.660</td>
<td>0.417</td>
<td>0.517</td>
<td>0.895</td>
</tr>
</tbody>
</table>
CHAPTER 3 - PART 2 RESEARCH

ENTERPRISE SYSTEMS AND ORGANIZATIONAL AGILITY: ERP AS A DYNAMIC SOURCE OF CHANGE, COMPLEXITY, AND RISK

Abstract

The literature is silent about how organizations that have implemented Enterprise Resource Planning (ERP) solutions reconcile the use of these rigid platforms in turbulent competitive environments. We studied three diverse organizations – a $9 billion retailer, a $3 billion consumer products firm and a $2 billion logistics company – all with ERP solutions in the sustainment phase, to shed light on the impact of changing business needs on platform reconciliation. Semi-structured interviews with 24 business and technical professionals revealed that in addition to economic and competitive forces for change to the ERP system, the system itself is paradoxically a driver of change. Structuration theory and specifically adaptive structuration theory (AST) explain the reconciliation process to reduce change-provoking cross-boundary complexity and systemic risk during ERP sustainment. Our findings promote a holistic perspective of enterprise platforms, encompassing both implementation and maintenance of ERP solutions and call for better alignment of ERP solutions and the changing needs of the enterprise.

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4Paper accepted and presented at 2010 Academy of Management (AOM) Annual Meeting, San Antonio, TX.
Key words: ERP, Enterprise Resource Planning, reconciliation, adaptation activities, structure, appropriation, Adaptive Structuration Theory (AST), complexity, risk
Introduction

Organizations are under increasing pressure to be agile in the face of continuous innovation, changing competitive forces, and a dynamic global landscape (Doz & Kosonen, 2008; Goldman et al., 1995), and information technologies such as Enterprise Resource Planning (ERP) systems can, in many ways support this agility on an organizational level (Sambamurthy et al., 2003). However, these enterprise-wide systems are developed using standardized business models believed to represent best practices (Wagner et al., 2006) rather than around the needs of any particular business. Still, these systems are expected to integrate and automate an enterprise’s back-end business processes across a wide variety of organizational contexts in a dynamic and changing environment. In the face of the organizational diversity and environmental turbulence driving the need to be agile, business processes often need to readily adapt and change. Yet, many consider ERP solutions to be complex, rigid and difficult to change (Sharma & Yetton, 2003), and thus might impede this agility.

The literature on ERP is dominated by studies about its implementation (Dowlatshahi, 2005; Gargeya & Brady, 2005; Hong & Kim, 2002; Motwani et al., 2005). However, relatively little is known about how organizations manage the contrast between externally imposed needs for agility and internally constrained ERP solutions in the post implementation phase. The process by which organizations reconcile continually changing business demands with the potentially static nature of the functionality designed into the ERP system is little understood. Thus we ask the following questions:

- How do organizations reconcile continually changing business needs with existing ERP systems?
What are the outcomes of this reconciliation process?

To address these questions, we studied three diverse organizations – a $9 billion retailer, a $3 billion consumer products firm and a $2 billion logistics company – all with ERP solutions in the sustainment phase. We conducted extensive interviews with 24 business and technical professionals looking for rich descriptions of the way that these organizations reconciled demands for organizational agility with the standardization associated with the ERP system. We find that organizations all follow a similar pattern in reconciling their demands for agility with existing ERP-related practices. However, we also found three second-order effects of this reconciliation process which cast the ERP system as a force for continuous change in itself, as well as a driver of certain forms of complexity and risk. The remainder of the paper is organized as follows. First we briefly attend to the literature on enterprise systems and agility, and then we present our research. We conclude with a reflection on the applicability of adaptive structuration theory and implications for practice.

**Literature Review**

ERP systems are large-scale packaged software solutions that integrate and automate many enterprise-wide organizational processes, particularly those associated with the operations or production and distribution functions of a company (Davenport, 1998). Klaus et al. (2000) studied the evolution of the term ERP from its roots in material requirements planning (MRP), one of the first off the-shelf inventory management business applications designed in the 1950s (Orlicky, 1975). During the 1970s and 1980s, MRP packages were enhanced across the entire manufacturing plant to MRPII
(manufacturing resource planning), with support for entire production planning processes as well as computer-aided processes (Chung & Snyder, 2000). In the early 1990s, MRPII underwent large scale functional integration with non-manufacturing processes across the enterprise, including sales, finance, distribution, human resources, etc. to be called enterprise resource planning (ERP) systems.

ERP systems are characterized by two key attributes which distinguish them from earlier classes of information systems. First, ERP solutions incorporate large scale integration of diverse and disparate enterprise processes such as finance, sales, marketing, manufacturing, warehousing, distribution, product development, etc. (Markus & Tanis, 2000). At the same time, since ERP solutions are purchased or leased by a large number of organizations from a single software vendor, they are not built around the specific business processes of an individual organization (Sharma & Yetton, 2003), but designed around business models which are considered to be best practices by the ERP vendor (Wagner et al., 2006). As a result, ERP solutions are perceived to be constrained, rigid and difficult to implement and change. They impose challenges on the adopting organizations, in terms of resources, redesign or realignment of business processes and organizational change management. However, compared to the plentiful literature on ERP implementation (Hong & Kim, 2002; Motwani et al., 2005; Sumner, 2000), relatively little research has addressed the sustainment phase. The limited research in this area focuses on maintenance activities and the classification, taxonomy and strategies of such activities. Nah et al. (2001), for example, identified maintenance activities pertaining to ERP solutions, classifying them into six categories (corrective, adaptive, perfective, preventive, user support and external parties coordination), concluding that
ERP maintenance cannot be sufficiently described by existing software maintenance taxonomies and proposing a benefits-oriented one. Nikolopoulos et al. (2003) studied the sustainment phase of ERP through the prism of an industrial maintenance strategy and proposed an object-oriented maintenance management model.

Much of the research that does focus on the post-implementation ongoing maintenance of ERP systems often highlights the alignment gaps that form between the system and organizational practice. Immediately upon implementation, packaged information systems inevitably misalign with existing organizational practices (Leonard-Barton, 1988). The post-implementation period is therefore often characterized by a period of mutual adaptation, whereby both the organizational practices and the system characteristics are changed to result in increased alignment (Leonard-Barton, 1988; Orlikowski, 1996; Tyre & Orlikowski, 1994). Research into enterprise systems, addresses this initial misalignment, by highlighting the “gaps” or “differences” between technology and the organization (Davenport, 1998; Soh & Sia, 2004). Accordingly, alignment takes place when either the technology is appropriated in a way consistent with the organizational practice, or the organizational practice shifts to become consistent with the technology. Organizations can engage in a number of adaptation activities by which organizations can bridge the gaps or misalignments in ERP solutions, or remain loosely coupled (Berente & Yoo, 2011). ERP solution vendors analyze the business processes in organizations and build solutions around standard ‘best practices’ business processes. Hence one key adaptation activity is to change business processes to align with those embedded in the ERP solution design (Davenport, 1998). This involves business process re-engineering (BPR), for which change management is critical (Grover et al., 1995).
ERP solution vendors also provide a limited ability to adapt business processes embedded within the solution through a process called ‘configuration’ (Markus & Tanis, 2000). Hence another important adaptation activity is for the organization to leverage ‘configuration’ options provided by the ERP solution.

Alignment gaps are not static by nature, and multiple factors can be responsible for their change over time. Sia & Soh (2007) argue that sources of alignment gaps are differences between the structures embedded in the package and those embedded in the organization – sources that reflect the different institutional context of the ERP package developer and that of the implementing organization. Some of these organizational structures are imposed while others are voluntarily adopted. The organization has less control in the case of imposed structures and alignment gaps – and such imposed structures are usually resolved through package customization.

Changing business needs of the organization during the sustainment or maintenance phase of the ERP solution can be another source of alignment gaps, and this is particularly salient in the modern, turbulent environmental context within which firms must operate (Kahn, 1994; Parente, 1996). The confluence of free trade, open communications, highly prevalent computing and globalization has resulted in a dynamic and unpredictable environment for many contemporary organizations. Organizations must be agile in order to successfully navigate this turbulence (Doz & Kosonen, 2008), and Sambamurthy et al. (2003) argue that information systems enable this agility by acting as digital options for adaptability on an organizational level, and the capabilities associated with information systems contribute to an organization’s entrepreneurial alertness and other capabilities that enable agility. However, ERP systems can be quite
rigid and difficult to change (Sharma & Yetton, 2003), particularly on the level of local business processes. Thus, a firm’s response to changing business needs can result in altered organization structures and corresponding business processes within the organization, giving rise to an alignment gap between the structures embedded in the organization and those embedded within the ERP. This also results in an adaptation activity to bridge such a gap. Although research has identified some of the types of adaptation activities that address the misalignment gaps (Davenport, 1998; Lapointe & Rivard, 2005; Markus & Tanis, 2000; Sia & Soh, 2007), the exact process by which an organization reconciles such changing business needs while operating in a turbulent environment, so as to minimize the ERP alignment gap, has not been well articulated. Next we present our research into the ways that organizations reconcile their changing environment with the standardized ERP system.

Research

Methodology

Grounded theory is a method of comparative analysis used in the social sciences that applies techniques which allow theory to “emerge” from data using rigorous analytic practices (Strauss & Corbin, 1998). This differs from the positivist approach of attempting to verify a theory with data. Researchers can easily conceive ideas that serve as theories, but since the ideas were not determined from the data, they may not accurately represent the circumstances (Glaser & Strauss, 1967). Since the goal of this research was to spawn new understandings regarding the reconciliation process between changing business needs and ERP, we adopted an exploratory approach based on the
Glaser & Strauss’ (1967) grounded theory framework. Our research was conducted using semi-structured interviews as the primary method of data collection.

Two distinguishing features of grounded theory are comparative analysis and theoretical sampling (Strauss & Corbin, 1998). Comparative analysis refers to the immediate commencement of data analysis simultaneous with its collection. Theoretical sampling refers to the reliance on a sample which is continually refined as the research progresses rather than dictated a priori. Both techniques were adopted in our research as were the rigorous data analysis techniques recommended by Strauss & Corbin (1998).

**Sample**

We studied three organizations in ERP sustainment phase which were in disparate industry types – retail (Org1), logistics and transportation (Org2) and consumer packaged goods (Org3). All three organizations implemented SAP as their ERP solution and all used the Accelerated SAP (ASAP) methodology of ERP implementation. ASAP divides the ERP implementation phase into five distinct phases – project preparation, business blueprint, realization, final preparation and go-live & support – with rigorous and mandatory gates before each phase.

Org1 has revenues of approximately $9 billion. This industry typically has high margins of approximately 20-30%. However, recent growth of Internet retailers, retail consolidation, and niche markets has put pressure on this organization, its margins and its market share. Org1 first implemented SAP in 2003. Of the three organizations researched, it had the most expensive ERP implementation at an estimated cost in excess of $200 million and used a Big 4 consulting partner when implementing SAP. Org2
started out in the railroad transportation business but has since grown to intermodal transportation. This firm has revenues of approximately $2 billion, has wafer-thin margins of approximately 2-3%, and is under continuous pressure due to the commoditized nature of third party logistics services, rising fuel costs and the recently slumping global economy. It implemented ERP in 2007, adopting a hybrid approach of using SAP and independent consultants and had the lowest cost ERP implementation of the three firms in our sample, estimated at $5-10 million. Org3, with revenues of approximately $3 billion, has manufacturing, warehousing and distribution facilities in the US, as well as a substantial presence internationally and operates with margins of approximately 5-10%. Although this organization holds a dominant market share in almost every market segment it competes in, it is under constant price pressure due to the purchasing power of large-box retailers. It implemented SAP in 1999 at an estimated cost of $50-60 million with the support of a Big 4 consulting partner.

Table 5 below summarizes the key characteristics of these three organizations.

**TABLE 5**

**Key Organizational Characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Organization 1 (Org1)</th>
<th>Organization 2 (Org2)</th>
<th>Organization 3 (Org3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry type</td>
<td>Retail</td>
<td>Transportation/Logistics</td>
<td>Consumer Packaged Goods/Services</td>
</tr>
<tr>
<td>Revenues</td>
<td>$9 billion</td>
<td>$2 billion</td>
<td>$3 billion</td>
</tr>
<tr>
<td>Year of ERP impl.</td>
<td>2003</td>
<td>2007</td>
<td>1999</td>
</tr>
<tr>
<td>ERP solution</td>
<td>SAP</td>
<td>SAP</td>
<td>SAP</td>
</tr>
<tr>
<td>ERP Impl. Method</td>
<td>ASAP</td>
<td>ASAP</td>
<td>ASAP</td>
</tr>
</tbody>
</table>
Interviews were conducted with employees in each of these organizations, both in business and IT. The positions occupied by the interviewees in each of the organizations ranged from a senior analyst, through manager, director, vice-president to a C-level role. Approximately half of the respondents in each organization were from business, while the remaining half was from IT. A total of eight interviewees were identified in each organization, resulting in twenty-four interviews.

Respondents were sourced directly or indirectly from the researcher’s professional network developed over 15 years of work in the ERP space. Respondent criteria were communicated to colleagues who worked in senior management roles in each of the three targeted organizations. These executives nominated and facilitated introductions to potential interviewees. The key criteria for interviewee selection were participation in the sustainment or maintenance phase of the ERP solution in the organization, in the roles of business users, IT support professionals or management.

**Data Collection**

We conducted semi-structured interviews using an interview protocol featuring open-ended questions. Respondents were contacted by telephone or email to ascertain their willingness to participate in a one to two hour interview. The interviews were conducted in-person at a location selected by the respondent to ensure comfort, safety, and confidentiality. At the beginning of the interview, respondents were reminded that the data collected were confidential and that they could stop the interview at any time. Interviews were recorded via two digital voice recorders and subsequently transcribed by
a professional service. In addition, notes were taken by the researcher during the interview to document non-verbal data and to capture immediate ideas and insights.

Interview questions (see Appendix A) were designed to gain deep understanding about how business users, IT professionals and managers reconcile changing business needs with ERP in the sustainment phase. Consistent with grounded theory, interview questions concentrated on the actual experiences of the respondents. The first question was intended to gain insight about the professional role of the respondents in their respective organizations as well as their roles in ERP solutions during both implementation and sustainment phases. Respondents were then asked to describe the range of business changes recently occurring in the organization. Probes were used to clarify and amplify responses. One or two specific changes were pinpointed by the interviewer and the respondents were asked to describe these in detail. Respondents were asked to describe their organizations as well as their individual roles, before and after the change. Finally, they were asked to share stories about how these changes were reconciled with their organizations’ ERP solutions. Early insights from initial interviews were used to fine tune the questions for subsequent interviews.

Data Analysis

Data analysis was initiated through rigorous, iterative coding of the interview transcripts. The recorded interviews were listened to multiple times and the written transcripts read repeatedly. Consistent with recommendations of Strauss & Corbin (1998), a line by line open coding of each page of every transcript was manually conducted to identify “codable moments,” – fragments of data with potential
significance. Using an open coding technique, over 400 “codable moments” were identified and later reduced to set of 193 core codes. These core codes were then captured in a spreadsheet and categorized and sub-categorized based on similarities or dissimilarities between the codes. In the next phase, the categories of codes were put together in new ways by making connections between categories and sub-categories, resulting in the development of 12 high-level themes. In the last phase, high-level themes were subsequently grouped into five core categories, which were the source of our findings.

Table 6 below shows the core categories identified and the associated themes.

**TABLE 6**
Core Categories & Themes

<table>
<thead>
<tr>
<th>Core Categories</th>
<th>Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of change</td>
<td>Exogenous - Competition, Economy</td>
</tr>
<tr>
<td></td>
<td>Endogenous - ERP itself is a source of change</td>
</tr>
<tr>
<td>Adaptation activities</td>
<td>Blurring distinction between business &amp; IT</td>
</tr>
<tr>
<td></td>
<td>Use of scorecards, modeling techniques, working sponsor groups</td>
</tr>
<tr>
<td></td>
<td>Data governance &amp; discipline</td>
</tr>
<tr>
<td></td>
<td>Change management activities</td>
</tr>
<tr>
<td></td>
<td>Effective utilization and training of resources</td>
</tr>
</tbody>
</table>
Consequences of adaptation activities

| Increased value and alignment |
| Additional risks due to adaptation activities |
| Reduced internal agility in response to adaptation activities. Go-slow so you can go fast model |

Leadership

Match in leadership style between business and IT leader is important in ERP sustainment phase

Organizational Culture

Organizational culture is a strong influence on adaptation activities during ERP sustainment

**Findings**

Despite their differences, all three organizations identified two sources of exogenous changes during ERP sustainment – competition and economy. Although competition and the need for agility were present before ERP implementation, they appeared to have *accelerated* in the last few years during the ERP sustainment phase, in alignment with, as one respondent described it, ‘the Google-ization of the information age’. His and other representative quotes that illustrate perceptions of exogenous change are presented in Table 7.
TABLE 7
Exogenous Changes

<table>
<thead>
<tr>
<th>Type of Exogenous Change</th>
<th>Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition-driven changes</td>
<td>“what I see from being in the retail space for quite a while, is that the drivers are the nimbleness around, in which you can put new concepts to market, whether that be a product… a marketing idea, …a store format idea, or a customer service model change. So I see that the nimbleness, the time to market, the agility, those are common threads across changes in this (ERP sustainment) period” – VP, Marketing</td>
</tr>
<tr>
<td></td>
<td>“Globalization …the information age …everything needs to be Google-ized, to be at my fingertips. So simplicity around time to market, and speed to market is the way that we live right now…so the viral social media that we have around, everybody's inclusion with Facebook, LinkedIn, Twitter, and those types of things, and that Google-ization of the information age” - CIO</td>
</tr>
<tr>
<td></td>
<td>“(the need to be) always connected at any point in time, 24-7, for… purchases… for information… for communication and connection: that inherently drives (us). Our time to market for products has to be quicker. How can we simplify from product manufacturing to the time the product's in the store, reduce those cycles; that’s the whole supply chain model optimization of the whole glass pipe around being able to optimize every link on that node” - Director, Sales</td>
</tr>
<tr>
<td></td>
<td>“…right now…what we call speed-to-market capability is really cornering – there’s so much competition now out there and the speed, the promotions and the deals, it’s getting those long-term customers in. So I definitely think it’s changed over the last few years, …” – VP, Business Operations</td>
</tr>
<tr>
<td>Economy-driven changes</td>
<td>“….in terms of the changes that we’ve seen, obviously the economic climate is probably the business change...’ – VP, Business Operations</td>
</tr>
<tr>
<td></td>
<td>“I think just for us, as an organization and then just from an industry perspective, the economic situation of the last two years has been very impactful”- Director, Strategy</td>
</tr>
<tr>
<td></td>
<td>“So outside influences, definitely, from the economy have driven change for us. The business just in their adoption of new, and then their reaction to the economy has driven change to us.” – VP, IT</td>
</tr>
</tbody>
</table>
Exogenous sourced changes – both competition and economy driven – often drove the organizations to make significant changes to their ERP solutions. To successfully execute on these changes, all three organizations reported cross-boundary teaming between IT and business as a key adaptation activity. Just as day-to-day cross-disciplinary business processes are integrated by the ERP system, our informants reported that business and IT personnel were increasingly integrated to implement the ERP changes. Each organization reported varying degrees of cross-boundary teaming. Org1 developed a centralized customer-facing team and data governance team comprised of business and IT team members. Such integrated teams were similar in concept to those created temporarily as part of a project team during implementation phase, however differed during sustainment in terms of the permanency of the structure as well as the depth of cross-disciplinary integration. Org2 was the last of the three organizations to implement ERP but was the most aggressive in recognizing the need to integrate IT and business. As an example, Org2 rotated business leaders into ERP IT leadership positions, a dramatic step resulting, for example, in a move from managing a P&L to a cost center. In a reverse direction, they also merged some of the technical aspects of ERP IT such as application security and development back into the business. Another interesting example shared by Org2 involved straw modeling exercises between business and IT to achieve a balance between anticipating what business wanted versus waiting for business to drive it. Table 8 illustrates some cross-boundary teaming mechanisms.
<table>
<thead>
<tr>
<th><strong>Cross-Boundary Teaming</strong></th>
<th><strong>Quote</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Need for cross-boundary teaming</strong></td>
<td>“the challenge that you have with centralized ERP versus decentralized systems is that when you’re more centralized (you need) common sets of business rules and definitions, and common sets of stewardship and governance around information data coming in to a system, and information and data coming out... So in order to manage the centralization of operations and data, we need to have ERP (IT) and business working as a single team” - VP Marketing</td>
</tr>
<tr>
<td><strong>New centralized organizational structures of business and IT</strong></td>
<td>“Now we have a central customer facing unit of business and IT for gathering requirements for ERP change which interact more with the business directly. And then we have a team that deals with data governance and deals with...if we are conforming to certain standards” – Manager, IT</td>
</tr>
<tr>
<td><strong>Rotation of business leadership into IT</strong></td>
<td>“we’ve rotated people in and out into the business, and into the IT organization, so that now, our IT organization at the leadership level is a mixture of IT and business leaders. This has helped us unlock the business acumen to leverage the ERP technology more effectively and address our business challenges.” – VP, Business Operations</td>
</tr>
<tr>
<td><strong>Technical ERP IT functions reporting to business</strong></td>
<td>“over the last two years...I’ve been working on how do you bring together a holistic view of business? A couple of months ago we actually did the last major organizational change to kind of bring the team into alignment. We now have ERP application development and security team moved from IT and reporting into my organization” – VP, Business Operations</td>
</tr>
<tr>
<td><strong>Straw modeling exercise between business and IT</strong></td>
<td>“So I think we’ve been very much in the role lately of doing the straw modeling...we just kind of locked ourselves in a room and said, okay, if we were in charge, what would we potentially do? We were very good in getting the business to understand, okay, there’s these ten things, and these ten things kind of roll up to this cost. It does this – well, can it do this, too? It could if you wanted it to, but it wasn’t in. So that’s where we started to get into the, this is why we need to have a much more in-depth conversation about what a good design might look like, and what do you really want to achieve as a business?” – VP, IT</td>
</tr>
</tbody>
</table>
Overall, the use of cross-boundary teaming mechanisms produced desired changes in the ERP sustainment phase. Table 9 illustrates the outcomes.

### TABLE 9

**Outcome of Cross-boundary Teaming**

<table>
<thead>
<tr>
<th>Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>“...we are now seeing with this approach a better alignment between customer and internal processes in ERP...” – VP, Marketing</td>
</tr>
<tr>
<td>“...so now we have a nice balance between understanding operational concepts (in business) and extracting more value out of the tool (in IT). So that’s been very beneficial...” – VP, Infrastructure</td>
</tr>
<tr>
<td>“...we know we (business and IT together) are getting faster. We know we’re getting more disciplined. We know we can pull off any business case needed by the organization...” – Director, Sales.</td>
</tr>
<tr>
<td>“... the organization is everyday realizing more value from the ERP with this (IT &amp; business integration) structure ...” – CIO.</td>
</tr>
</tbody>
</table>

Apart from the exogenous changes leading to cross-boundary teaming, we also observed the following second-order effects in the three organizations, which constitute three key findings of this research. Stories supporting the findings are also provided below.

**Finding#1 - ERP Itself Is Paradoxically a Driver of Change**

In addition to the economic and competitive forces for change to the ERP system, we found that the ERP system itself was often an endogenous driver of change. Often, as the organizations learned about the capabilities of the ERP system, particularly in
situations where new uses for ERP data were discovered, the system itself became a recursive force for change to the system.

For example, the VP of Logistics at Org3 described a significant change during ERP sustainment that had been initiated by the ERP implementation. ERP implementation provided the data, tools and analytics to understand business processes in the organization, which brought about ideas for changes to these processes. His example was about a “regional co-distribution” project:

“We implemented SAP across all of our product lines... we saw immediate value and efficiency at that time due to consolidation of nine different legacy systems into SAP. After we implemented SAP, we started feeding all the transactional information into the BW [Business Warehouse reporting tool] module of SAP. For the first time, the BW cubes allowed us to look at orders, deliveries, shipments, transportation routes, payments across all our product lines, across all customers and across all seasons. We started observing for our [one product line] business during specific seasons, we were shipping to a customer with less than truckload when at the same time we were shipping [another product line] to that same customer from another DC [distribution center] using less than truckload. The analysis of the SAP data across different product lines showed that there was a huge opportunity for us to save $XX million by changing our business process and co-distributing multiple products from a single DC without impacting our shipment timelines.” – VP, Logistics

This resulted in changes and optimizations to business processes. Since business processes are implemented and embedded within the ERP solution, this resulted in change to the ERP system.
“Once we realized this opportunity, we saw that we had to change our processes around DC consolidation, inter-DC goods transfers, and stock replenishment so that we could co-distribute [both product lines] using full truckload. Although changing our logistics processes was a big challenge, a bigger challenge was changing those processes in SAP. We needed to change SAP so that it could now process orders from customers for separate product lines in the same order, applying multiple pricing procedures across different product lines including customer specific volume discounts and then ship the products from the transportation module in SAP using a full truck load from the regional co-distribution center. Since this was a fundamental change in how SAP worked, we had to create a (project), get capital allocated and then had a cross-functional team of 20 people from IT and business work for six months on changing SAP for this new model” – VP, Logistics.

Informants indicated that ERP-driven change was continuous and ongoing. Many of the respondents offered examples to highlight the dynamic nature of the ERP sustainment phase. For example, as a result of the new co-distribution process mentioned above, further potential changes were identified:

“As a matter of fact, we are currently working on a project for analyzing the data from regional co-distribution implementation and we are realizing that we have another opportunity of almost $XXX million in further optimizing it to regional manufacturing. That is our next direction.” – VP, Logistics

All of these changes – both internally and externally driven – led to cross-disciplinary forms of organizing that were often novel to the organizations and which contributed significantly to the complexity of those organizations.
Finding#2 - Change Process and Cross-boundary Teaming Increases Complexity

The change process and associated cross-boundary teaming which was intended to make the overall organization more agile, often made local activity less agile – more rigid, slow and costly. Respondents described a number of situations where complexity gave rise to local rigidity and inefficiency, but ultimately fostered organizational agility.

To illustrate this idea, the VP of IT at Org1, providing another example of ERP-driven process change, explained that ERP implementation caused ‘several skeletons’ to come out of the closet during the sustainment phase.

“The thing that we found after SAP implementation, and you find this often times with any ERP implementation, is you find the skeletons in the closet. They found all kinds of bottled componentry, all kinds of crap componentry that were on the books that were tucked away in corners and places, never to be seen again. But you were carrying that. So one of the things that the project exposed was all that raw material stuff that was out there...We found a lot of old product...What we saw is we got rid of all the junk, so what do you want those stores to be now?...as we run out of junk, they want those stores now to look more normal, plus have a mix of new and marked-down inventory.” – VP, IT

‘Closet skeletons’ uncovered during ERP sustainment at Org1, resulted in many complex process changes in the stores and, subsequently, changes back in the ERP to support them.

“This (clearance stores carrying normal inventory) caused the processes in the stores to change completely. New processes now had to again be reconfigured and reimplemented in SAP which was additional work that we had to take on. As an example, in the newly configured clearance stores, we had a subcontractor who made what we call...
our splash product. We were having some disputes with that subcontractor. And the business proceeded to go off and find another subcontractor. Setting up that other subcontractor changed the model. So the previous subcontractor used to handle it and ship it straight to the stores for us. The new subcontractor makes it and he ships it to us to ship to the stores. And what no one thought about is this stuff does have a hazardous material category to it, which means you’ve got to handle it in certain ways. We had no facilities, or not large enough facilities to handle the volume. So that did happen during the latter days of the go-live back in May and June. But the business had a compelling case and said, “We’ve got to do this, we’ve got to save money.” And there was a big money savings associated as well, and we had to accept the work and went and did it.”

VP, IT

At the same time, these ERP changes required the organization to generate a completely new release management strategy in ERP.

“However this additional work slowed down and impacted other work in the pipeline for changes to SAP, and their associated interdependences in terms of the order in which many of the changes could be tested and rolled out to production. So we had to move towards what we call a release strategy. So instead of just making changes all the time, we’ve gone through a two-to-three release formal schedule a year. So we’ll work on requests and then issue those, let’s say, possibly in March of each year and August or September of each year. And that’ll be a collection, just like you would with a piece of software. They come out with the .1, .2, .3 release. We’re starting to do the same thing. So that process is a little more fuzzy—because we’re just getting started with it. So it’s
how do you govern that process and get the right things in the mix? And we’re going through the growing pains of that now.” – VP, IT

The new release management strategy gave rise to new complexity, for determining the right changes in every release.

“So as an example, we’re starting to think a lot about international stores, international capabilities. What happens if our release strategy is in March and say September, and let’s say there was a huge international launch in June. How will we accommodate that and will that be set up as a project? Or will that be set up as a release? And then once you start doing projects in there, how does that impact your release? So how are you going to get that right? Those are all just logistical things that we’ll have to deal with. And my guess is there will be a certain amount of tension around what’s in the release? How do you determine what’s in a release? What should the composition of a release be... like I said, we’re still in our growing pains of this and I would say there’s not alignment on how this should work.” – VP, IT

To address the additional complexity of getting the right number and types of changes in the next release of changes to ERP, the organization had to come up with a very elaborate cross-boundary teaming strategy to merge business and IT – and that governance structure had its own tension and complexity.

“So the way we do it today is we have these things called SIGs, which are special interest groups... And these SIGs are composed of, I’ll say, middle management and individual contributors. So our primary source of enhancement requests has been from those groups. But that is not sufficient...We need to hit into a much higher level in the
organization. So we have put together these groups that are called working sponsor groups throughout the organization. So there’s an MPNA working sponsor group that is made up of senior vice presidents and vice presidents of the brands. To figure out how much of what goes into which mix, we’ve start hitting the MPNA working sponsor group, the financial – we call it enterprise working sponsor group, the store’s working sponsor group. But we still need to go back to the SIGs as a way to move the ball forward. We need to keep going back and forth between the SIGs and the working sponsor groups.” - VP, IT

The cross-boundary governance structure generated additional local overhead which was, however, rationalized as necessary to ensure global agility.

“With these groups in place, we certainly have more overhead now. I would actually say our model of developing SIGs is probably more expensive than using the existing working sponsor group. So we’re applying overhead to build a SIG, prepare for SIG, to bring everybody together, to take them away from their jobs, just to talk about IT issues. All of which, in a sense, has the cost of slowing us down in supporting ERP and the business. However, I think that is a necessary cost for us to provide a better quality solution in ERP and meet the rapidly changing needs of business. I actually think it’s overall cheaper and I think it’ll give you a much better result.” – VP, IT

Of course, informants indicated that similar complexity arose from exogenously driven change, as well. For example, the VP of Marketing at Org1 provided another example of local inefficiency, due to second-order complexity initiated by the exogenous
change of agility. While earlier the store made changes once every 3-4 months, the need for agility motivated changes every 3-4 weeks.

“So I definitely think it (business) has changed in the last few years. We did new floor sets, and a floor set is where we put out fresh, new inventory, new styles, new colors, new whatever. You did it seasonally, so you had your spring season, and then you went into a little bit of a summer season, and you go into back to school, and then you would go into holiday season. So you did that four, maybe five times a year. We're doing that now every three to four weeks. I think it's all about cornering the market, continuing to grow your business, bring in those sales... you have to be able to spin it that quickly. Once you find out that you don't have a successful item selling, you've got to start moving on what's the next item. What's the consumer going to buy next?” - VP, Marketing

According to the VP, such exogenous agility driven changes, inevitably resulted in large changes in their ERP solution during the sustainment phase.

“When we moved to doing new floor sets every three to four weeks, it fundamentally changed our processes and how we do business in the stores. Our logistics process changed since now we had different ways of replenishment our inventory in the store. We had to go towards using a third party logistics provider. This changed how we had orders flowing into SAP from our stores as well as how those orders in SAP now had to get routed through the logistics provider for fulfillment instead of SAP following standard distribution process. With such a rapid turnover of new products and inventory, the financial processes for tracking inventory had to be changed in SAP due to some inventory now being at stores, some at the DC and some with logistics provider. Finally,
we also had to change pricing and promotion processes in SAP for the new inventory every time the floor sets changed ...is a big change in SAP.” - VP, Marketing

Adaptation activities in Org1 in response to these changes were based on cross boundary teaming which led to additional complexity (e.g. getting alignment on business rules, stewardship, governance and standards), which in turn gave rise to what the VP described as ‘go slow so you can go fast’ paradox:

“So it's that ‘go slow so you can go fast’ model that's really giving them the tagline on it. Spend more time planning, talking, designing in ERP and then execution will go easier” – VP, Marketing

The CIO of Org1 revealed that spending more time integrating and coordinating between IT and business made execution better, but also resulted in a potential slowdown within the organization. This resulted in tension between organizational agility and individual or local agility.

“I think the same problem that it's trying to solve, is also the same inhibitor, which is nimbleness, and time to market, and agility. As things become more complex and more integrated, and the processes are more sophisticated and more people need to be involved, while it's enabling me a better agility and time to market at the macro sense, (from) a work group perspective, it may not be the case. so where I could independently do things on my own, accomplish my work and my projects quicker, because I am essentially at the mercy of everybody in the organization's calendar, resources, timing, and alignment of prioritization, that alignment of all of the different
critical success factors may inhibit me in my personal time to market and (ability) to do things.” - CIO

Thus informants revealed that the many exogenous and endogenous forces of change brought about a variety of cross-boundary practices that dramatically and dynamically increased the complexity and decreased the efficiency of the organization. This complexity also had the effect of opening the organizations to new risks.

**Finding#3 - ERP-driven Complexity Increases Systemic Risks**

Informants described a variety of risks born of the continuous waves of change and the resulting cross-boundary complexity. For example, the VP of Business Operations at Org2 indicated that accelerated competition drove a need to acquire longer term contracts:

“Logistics has become very commoditized and more specifically the intermodal logistics area, where we were dominant earlier, has seen a large number of new players enter the market in the last couple of years. It’s a war out there to acquire, sign-up and keep long term contracts. We really need to move very fast now to acquire business and to execute on it.” – VP, Business Operations

In response to such changes in the ERP sustainment phase, the VP described how Org2 rotated business leaders into ERP leadership roles in IT, and merged some of the technical aspects of ERP IT responsibilities like application security and development back into the business.

Such an approach was not without drawbacks. A database administrator reported that his transfer from IT into business might risk compromising the organization’s
Sarbanes Oxley compliance. Sarbanes-Oxley, among other things, requires segregation of duty to avoid conflict of interest in certain contexts. As Org2 was a publicly traded company, subject to Sarbanes-Oxley, this risk was non-trivial.

“We used to be part of the technical organization, and now we’re part of the business organization… I think they structured it that way so that they felt that it being vertical and everyone being aligned it was going to be better... the fact (is) you are now working for the people that you're supposed to be watching out for... Separation of duties, exactly right, yeah. And so now, we're kind of part of the organization that's designing code, implementing code and validating code and watching all the security, so there (is) the potential for conflict of interest.” - Technical database admin

Similar risks were shared by Org1. An IT systems analyst, for example, elaborated on how additional complexity arose due to cross-border teaming and how this decreased local agility, but did so without improving efficiency or agility elsewhere. In essence, there was risk of ineffectiveness to the process change:

“with all the complexity now, the organization structure needed to be changed... now we have to have a customer facilitator who gathers all the requirements, interacts more with the business directly. And then we have a team that deals with data governance and deals with how we are conforming to certain standards, right? And then you have a specific group that deals with pure development who has the interaction with the team that takes care of the data governance and the stewardship. So before, we didn't have those components in our space, because we didn't need to. Now that it's much more complex, you need a structure put together to handle the complexity because if you just
have an ETL team to do all the requirements, the data governance, it's not possible because we have right now we are dealing with many different subject areas as opposed to what we did in the past. So that is the change that needed to happen organizationally in place. In some cases, it didn't really help with the speed up, but we needed that change to make sure that things get done properly and we don't really break things in the process.” – IT Systems Analyst

Beyond potential ineffectiveness, additional overhead resulted in slowing down locally, but at the same time led to increased pressure to move fast and get changes in ERP quickly, resulting in an increase in the risk of higher errors in ERP changes.

“,,,to take care of that time constraint what's happening is ... we have more people working in some spaces. And people are working many hours to cover that, right? So if you think about it, people who have been involved, the number of hours that they've put in is monumental. It's unbelievable. It has increased the risk of people making mistakes and breaking down the chain of things.” - IT Systems Analyst

The analyst emphasized that the quality risks went beyond outright errors but also included poor decision making. Because of this pressure, risk was also rising due to compromises in standards and this caused issues in ERP, requiring further changes in it.

“So to summarize, at the end, once everything is said and done, you see all those limitations start to manifest in the post-implementation period because...things don’t get done properly. Standards are not followed. You find too many issues. You find performance issues that you end up spending lot of time addressing. Those are the risks that I see.” - IT Systems Analyst
Discussion

We began our inquiry with a fairly linear perspective on ERP sustainment phase, conjecturing that organizations adapted to exogenous sources of changes through adaptation activities like cross-boundary teaming, as per Figure 3 below.

FIGURE 5
Initial Conceptual Model

This perspective, however, did not address the recursive relationship between ERP and processes in an organization and how ERP itself might constitute an endogenous source of change. Our initial perspective also could not address the second order effects of complexity, local rigidity and systemic risk that our findings indicate. Thus, to better characterize the non-linear and recursive nature of ERP adaptation that our data suggests, we updated this framework (see Figure 6).
In this model, our first finding indicates that there is a recursive relationship from process change to further process change (blue). While researchers have noted that ERP implementation is a continuous, never-ending “onward and upward” process (e.g. Markus & Tanis, 2000), it is not couched in terms of endogenous (i.e., internal to the organization) change. One exception to this is Ciborra’s (2000) model of increased efforts of control in the context of ERP recursively leading to drift and the resulting further attempts at control. While that characterization describes a grim situation of a runaway technology, ours highlights the positive aspects of this endogenous change. We found that as organizational members gain visibility to important data they find new uses for the data; as they experience the system they learn about the system. Thus the ERP implementation can, and perhaps should, never be settled once and for all.
Our second finding highlights how cross-disciplinary teaming adds to the complexity of ERP sustainment contexts. Since ERP systems span entire organizations, a variety of knowledge resources must be brought to bear on any change process. On the direct path (blue) this is necessary to bring about change, but on the indirect path (green) this cross-disciplinary teaming creates its own organizational practices and structures, brings about its own separate set of effects, and costs the organization in local efficiency and overhead. While the process which is the object of any given change is commonly scrutinized quite extensively, the overhead complexity that may counterweigh any efficiency gains is often ignored.

Sambamurthy et al. (2003) have argued that information systems like ERP are platforms that enable organizational agility through increased organizational capabilities around efficiency and flexibility. During the ERP sustainment phase this platform faces multiple forces of changes such as competition and economy driven changes, which increase the uncertainties facing the organization. Gattiker & Goodhue (2004) proposed that numerous modes of coordination arise in an organization to address such uncertainties. Since ERP solutions span multiple sub-units across an entire enterprise, cross boundary teaming and collaboration across business and IT is an example of coordination. Such cross-boundary teaming results in process changes and additional complexity, in the organization in response to externally and internally sourced change.

Further, this complexity introduces additional risk into the organization, as our third finding indicates (red). In one example, the new reporting structures bring about potential exposure to regulatory compliance issues (i.e., Sarbanes-Oxley), which could pose a disproportionately large risk to the overall organization. These risks can include
internally driven risks that involve anything from software failure and organizational problems (Lyytinen & Mathiassen, 1998) to technological risks which involve broader security concerns (Longstaff et al., 2000).

Our research indicates a nuanced relationship between ERP and process, whereby ERP implementation provides data, tools and analytics to analyze business processes and optimize them – and results in second-order changes back in the ERP. A theoretical lens to understand such ERP driven changes is provided by structuration theory (Poole & DeSanctis, 2004).

Adaptive structuration theory (AST) was originally proposed by DeSanctis & Poole (1994), as an extension to Giddens’ (1979) structuration theory to explain the structuration process in technology solutions. DeSanctis & Poole (1994) identified different forms of structures in organization where technology solutions are implemented. Structure of advanced information technology refers to the rules and resources provided by the technology. Other sources of structure refer to “content and constraints of a given work task” (DeSanctis & Poole, 1994) e.g. standard organizational procedures for computing budgets, pressure to reduce spending during budgeting process, etc.

Appropriations are an important concept in AST. They are described as the “immediate visible actions that evidence deeper structuration processes” (DeSanctis & Poole, 1994). Appropriations are similar to the concept of modalities in structuration theory (Jones & Karsten, 2008). Appropriations are not automatically determined but rather selected by people through decision processes such as participation, task management, conflict management, etc. The nature of such appropriations depends on the group’s internal system. The interaction between appropriations and decision processes result in decision
outcomes such as efficiency and quality of the solution, as well as results in production and reproduction of new social structures and new emergent sources of structure for the technology. The key constructs of AST are illustrated in Appendix B. We used the AST theoretical framework to explain our findings, themes (from Table 6) and the constructs in our final conceptual model, as per Figure 7 below.

FIGURE 7
Application of AST framework to Final Conceptual Model

The integrated rules of the organizational processes that are embedded within an ERP after it has been implemented in an organization are a key source of technology structure in that organization. In addition, the external environment characterized by competition and economy as well as internal environment characterized by organizational culture, serve as other sources of structure. After the ERP is implemented in the organization, these structures are appropriated through multiple mechanisms – business
changes driven by competition and economy, the use of data analytic tools and mechanisms to study the effectiveness of processes in the organizations as well as data governance mechanisms to maintain the integrity of the solution. As per AST, such appropriations do not happen automatically, but are supported by people through decision processes, such as cross-boundary teaming between business and IT. Such decision processes are also influenced by the organization’s internal system, which includes leadership style. The interaction between appropriations and decision processes during ERP sustainment phase, results in the following three outcomes.

- **Emergence of new sources of structure** in the ERP solution (through implementation of new optimized processes and corresponding changes back in ERP) as well as in the organization (through decreased local agility). Findings 1 and Finding 2 reflect this change.

- **Complexity and systemic risk as a decision outcome** of the decision process elements in AST of task management, conflict management and behavior influence. Findings 2 and 3 reflect this change.

- **Development of a new social structure** in the organization, incorporating a blurring between the functions of business and IT, in order to have effective decision processes e.g. rotation of business leadership into IT and technical ERP IT functions reporting to business.
Limitations

Several limitations of the research should be noted. Our sample consisted of IT and business professionals employed by only three firms in three industries (retail, transportation and consumer products). Our findings may not be generalizable to other industries or to other firms in the same industries. We interviewed only eight business and technical professionals in each firm. Including more and a broader range of professionals could have influenced our findings.

Our respondents represented a range of functional responsibilities covering management, business and IT. Despite this broad organizational spectrum, the full range of changes impacting a given organization in the sustainment phase of an ERP solution may not have been available to any single respondent.

Although a conscious effort was made to reduce researcher bias, the principle researcher’s extensive professional experience in the field of ERP implementation and sustainment may have affected his analysis or interpretation of the data.

Implications for Practice and Future Research

We sought to provide insight to practitioners and scholars about the processes by which changing business needs are reconciled against the static processes embedded within an ERP system during its sustainment phase. Our findings should be considered suggestive rather than conclusive evidence about ERP sustainment phase processes. We recommend that managers of organizations in the sustainment phase of ERP consider an ERP solution as a dynamic phenomenon. The ERP solution itself can be a source of change, in addition to competition and market driven forces. Second, management of
organizations, even in implementation phase, should be aware of the duality between ERP and processes so that they can plan appropriate support strategy, organizational structure, resource staffing and budgeting. Third, senior executives need to consider mechanisms for strong alignment between IT and business to maximize alignment and ERP performance during the ERP sustainment phase. Fourth, senior management must realize that many of the decision outcomes in the ERP sustainment phase may be leading the organization to take on additional risks, which would need to be effectively identified, managed and mitigated.

Our study suggests a number of areas for further research. Replication of the research involving other firms in other industries is recommended. Correlation between structures, appropriations, decision processes and decision outcomes in the ERP sustainment phase would provide further insight into the applicability as well as predictability of AST. Further research in organizations in both the implementation phase for certain business units or functional processes as well as in sustainment phase for other business units or functional processes can provide a more holistic picture of this phenomenon. Finally, research into the adaptation activity of rotation between business leaders and IT leadership roles can provide a better understanding of its effectiveness.

**Conclusion**

ERP systems comprise one of the largest administrative investments in contemporary organizations, and these systems streamline and integrate a variety of organizational processes. However, when faced with the demand for change from their turbulent environments, these systems can impede the required change and must
themselves adapt in order for organizations to be agile. This continuous adaptation of the ERP system brings about a variety of second-order effects. First, the ERP system itself can be a driver of change to the ERP system, as individuals learn more about the system and its capabilities. Further, organizations form cross-disciplinary groups to bring about necessary adaptation, but these cross-disciplinary groups lead to the unintended consequences of increased complexity and potential risk. Researchers and practitioners alike would do well to attend to these second-order effects when dealing with ERP systems.
Appendix A - Interview Questions

1. Tell me about your role in the organization.

   Additional probing questions
   
   a. How do you use ERP solutions in your current role?
   
   b. What was your role in the organization during implementation of the ERP solution?
   
   c. What is/was your role in the organization during sustainment or maintenance of the ERP solution?

2. Describe to me the business changes that are/have been happening in your organization.

   Additional probing questions
   
   a. Are these changes internal to your organization or external?
   
   b. What are the businesses changes happening in your industry?

3. Tell me more about some of these specific changes in your business.

   Additional probing questions
   
   a. What is/was the change?
   
   b. How were things in the organization/your role before the change?
   
   c. How are things in the organization/your role after the change?
   
   d. How did you react to these changes? What did you think?

4. How did you reconcile these business changes with the ERP solution?

   a. Describe the limitations and issues that you encountered in this situation.
   
   b. Describe the leadership and organizational culture in your organization during this situation.

5. Is there anything else that I may have missed out on, that you would like to share?
Appendix B - Constructs in Adaptive Structuration Theory

Structure of Advanced Information Technology
- Structural Features
- Spirit
- Leadership
- Atmosphere

Other Sources of Structure
- Task
- Organization environment

Group's Internal System
- Styles of interacting
- Knowledge with structures/perceptions of others' knowledge
- Agreement on appropriations

Social Interaction Appropriation Process

Appropriation of Structures

Decision Processes

Emergent Sources of Structure

Decision Outcomes
- Efficiency
- Quality
- Consensus
- Commitment

New Social Structures
CHAPTER 4 - PART 3 RESEARCH

EFFECTS OF ORGANIZATIONAL KNOWLEDGE AND COMPETENCIES ON THE IMPACT OF ENTERPRISE SYSTEMS ON ORGANIZATIONAL AGILITY

Abstract

Recent research has leveraged innovation assimilation literature to provide the interesting result that higher assimilation levels of ERP in an organization have a net positive influence on organizational agility, and that the dynamic capability of systems agility moderates the effects of assimilation levels of ERP on agility. In this paper, we extend this research, to investigate the knowledge conditions under which complex process-oriented technology innovations like enterprise systems influence organizational agility in dynamic markets. We propose a theoretical framework incorporating two key organizational competencies – IT Competence in Business (ITCB) and Business Competence in IT (BCIT) – and theorize that both ITCB and BCIT have a dual effect on organizational agility – by being mediated by systems agility in influencing organizational agility as well as by moderating the effect of ERP assimilation on organizational agility. To empirically validate the proposed theoretical framework, we conducted quantitative cross sectorial survey across 215 SAP user organizations. The results validate our key theorizing on the dual effects of ITCB and BCIT on organizational agility. In addition, we obtained two surprising results. Systems agility
fully mediates the positive influence of ITCB and partially mediates the positive influence of BCIT, on organizational agility. Moreover, when an organization has both high levels of IT competence in business as well as high ERP assimilation, we see surprising results in the negative moderating effects of ITCB on the influence of ERP assimilation on organizational agility. This implies that higher IT competence in business is potentially a barrier to the positive influence of ERP systems on organizational agility at higher ERP assimilation.

**Key words:** Enterprise systems, ERP, organizational agility, systems agility, innovation, assimilation, dynamic capabilities, IT competence in business, business competence in IT
Introduction

Over the last two decades, enterprises have been operating in increasingly competitive and turbulent environments, which require them to be highly agile in their response. During the same timeframe, enterprises have undertaken widespread deployment of enterprise systems such as enterprise resource planning (ERP) solutions, which are large-scale packaged software solutions that integrate and automate many enterprise-wide organizational processes. Literature review indicates an apparent paradox by giving competing perspectives on whether enterprise systems promote or hinder an organization’s ability to be agile (Goodhue et al., 2009). However, recent research (Kharabe, 2012:1) has leveraged innovation assimilation literature to provide the interesting result that higher assimilation levels of ERP in an organization have an overall positive influence on organizational agility. In addition, the speed of systems development capabilities, as exemplified by the dynamic organizational capability of systems agility, has not only been shown to have a direct effect on organizational agility, but it also moderates the effect of assimilation levels of ERP on agility, thus playing a pivotal role in explaining the apparent paradox of enterprise systems both promoting and hindering organizational agility.

In this paper, we extend the work from Kharabe (2012:1), to investigate the conditions under which innovations such as enterprise systems influence organizational agility in dynamic markets. Dynamic capabilities, defined as the ability to “integrate, build, and reconfigure internal and external competencies to address rapidly changing environments” (Teece et al., 1997), can be a source of sustained competitive advantage to
organizations operating in turbulent markets. Apart from the dynamic capability of systems agility, which has already been shown to be a powerful and critical enabler for influencing the positive impact of ERP assimilation level on organization agility (Kharabe, 2012:1), the capability to rapidly integrate knowledge resources is also considered critical in dynamic markets (Grant, 1996). Eisenhardt & Martin (2000) have highlighted that in moderately dynamic markets, existing and detailed knowledge form the foundation for dynamic capabilities while in highly dynamic markets, simple and new knowledge underlies the dynamic capabilities of the firm. In either case, organizational knowledge and competencies seem to influence the ability of organizations to be agile. Leveraging the qualitative results from Kharabe (2012:2), we propose a theoretical framework of two key organizational competencies – IT Competence in Business (ITCB) and Business Competence in IT (BCIT) – to understand the role of specific knowledge conditions under which assimilation of innovations like ERP influence organizational agility. We extend the nomological network from Kharabe (2012:1) by theorizing that both ITCB and BCIT have a dual effect on organizational agility – by being mediated by systems agility in influencing organizational agility, as well as by moderating the effect of ERP assimilation on organizational agility.

To empirically validate the proposed theoretical framework, we conducted a quantitative cross sectorial survey across 215 organizations to detect both the mediating and moderating influences on organizational agility. The results not only confirm the nomological network from Kharabe (2012:1) but also validate our key theorizing in this paper on the dual effects of ITCB and BCIT on organizational agility. In addition, we obtained two surprising results. Systems agility fully and strongly mediates the positive
influence of ITCB and partially mediates the positive influence of BCIT, on organizational agility, implying the necessity of higher levels of the dynamic capability of systems agility for organizations to capture the strong influence of knowledge competencies on their ability to be agile. Moreover, when an organization has both high levels of IT competence in business as well as high ERP assimilation, we see surprising results in the negative moderating effects of ITCB on the influence of ERP assimilation on organizational agility. In this condition, higher ERP assimilation not only fails to result in higher organizational agility, but in addition, organizational agility decreases slightly with higher ERP assimilation. This implies that higher IT competence in business is potentially a barrier to the positive influence of ERP systems on organizational agility at higher ERP assimilation, potentially due to IT substitutes effect or organizational hubris.

The remainder of the paper is structured as follows. First we briefly review the literature on enterprise systems and organizational agility. Next, we leverage prior research to systematically develop a theoretical framework that organizes ERP assimilation, systems agility, organizational agility, IT competence in business and business competence in IT to explain the dual effects of knowledge competencies on organizational agility. This also includes our postulation on the interaction effects between ERP assimilation levels and the moderators of systems agility, ITCB and BCIT. Then we report our empirical research and review the findings. We conclude with a reflection on the implications of the research in this paper for theory and for practice.
**Literature Review**

*ERP* (Enterprise Resource Planning) *systems* are large-scale packaged software solutions that integrate and automate enterprise-wide organizational processes (Davenport, 1998). On the other hand, *enterprise systems* are a portfolio of information systems which integrate transaction processing with data analysis, data reporting and data flow across enterprise-wide units, functions and processes. Since ERP systems typically form the core transaction processing foundation of an enterprise-wide system portfolio, the terms ‘ERP systems’ and ‘enterprise systems’ will be used interchangeably and synonymously in this paper. ERP systems are characterized by three key attributes, which distinguish them from earlier classes of information systems - very large scale integration of diverse and disparate enterprise processes (Markus & Tanis, 2000), real-time architecture enabling the real-time creation, propagation and consumption of information across almost all functions of the firm (Bingi et al., 1999) and a core design based on generic functional business models, which are considered to reflect ‘best industry practices’ (Wagner et al., 2006).

A review of literature in strategic management, operations, marketing and information systems reveals that the definition and dimensions of *organizational agility* has continued to evolve with time and across disciplines, leading to a lack of theoretical clarity for the construct (Schnackenberg et al., 2011). A review of this evolution reveals the three key characteristics of organizational agility – *speed of organizational change* (Judge & Miller, 1991), *ease of organizational change* (Bahrami, 1992; Hayes & Pisano, 1994), and a *sensing and responding* mechanism with reference to an organization’s environment (Sambamurthy et al., 2003). For this paper, we chose to use the following
definition of organizational agility from Tallon & Pinsonneault (2011), since it not only emphasizes and highlights all these three characteristics of speed of change, ease of change and sensing/responding, but also adds a dimension of dexterity implying the need for organizations to achieve an appropriate balance amongst competing requirements:

“(Organizational) agility (is) defined as the ability to detect and respond to opportunities and threats in the environment with ease, speed and dexterity” (Tallon & Pinsonneault, 2011, p. 464)

**Theory Development: Enterprise Systems, Organizational Agility and Organizational Knowledge**

To build a theoretical framework encompassing enterprise systems, organizational agility and organizational knowledge, we leveraged the nomological network from Kharabe (2012:1), which starts out with the postulation that analysis of the complex interaction between enterprise systems and organizational agility requires moving beyond the simple idea of ERP presence or absence influencing agility to the idea of ERP effects. Theories of technology innovation suggest that the key effect of technology innovations on organizations is determined by the extent to which the innovation is assimilated within the organization (Armstrong & Sambamurthy, 1999; Zmud & Apple, 1992). Specifically, the nomological network leverages the construct of ERP assimilation from Liang et al. (2007), based on the definition of assimilation by Purvis et al. (2001) as “the extent to which the use of technology (ERP) diffuses across the organizational projects or work processes and becomes routinized in the activities of those projects and processes”. Using this concept of ERP assimilation along its dimensions of diffusion and routinization in
conjunction with literature from *knowledge-based* views, *capabilities-based* views, *resource-based* views and *risk-based* views, the nomological network indicates that the sum of the simultaneous positive and negative effects of ERP assimilation on organizational agility results in a *net positive* impact on organizational agility. We add this result from Kharabe (2012:1) as the first key hypothesis to validate in the theoretical framework of this paper.

*Hypothesis 1: ERP assimilation has a net positive impact on organizational agility*

Next, Kharabe (2012:1) combines insights from dynamic capabilities literature as well as from agile systems literature to theorize that the *speed* of system development capabilities, in support of changes to information systems to closely match dynamic organizational processes and products, would have an effect on organizational agility. Using the dynamic capability of systems agility, defined as “*the organizational ability to successfully and swiftly change its information systems*” (Davis, 2009), as a measure of this *speed* of system development capabilities, Kharabe (2012:1) suggests that the higher the systems agility capability in an organization, the higher would be the *swiftness* and *success* of changes to information systems in the organization. Such higher *swiftness* and *success* of information systems change would increase the speed at which supported business processes and product strategies could change in response to dynamic markets, resulting in higher organizational agility (it is to be noted from the definition of systems agility that it *implicitly* encompasses swift and successful changes to *all* information
systems and is not limited to only enterprise systems). We add this result as a key hypothesis to validate in the theoretical framework of this paper:

**Hypothesis 2:** Systems agility positively impacts organizational agility

Finally, Kharabe (2012:1) argues that higher systems agility can influence the impact of ERP **diffusion** on organization agility through a) increased **unit scope diffusion**, when existing ERP modules are more quickly **extended** to be rolled out to additional business units in the organization, as well as through b) increased **functional scope diffusion**, when additional ERP modules are more quickly **configured** to be rolled out within existing business units in the organization. Similarly, higher systems agility can influence the impact of ERP **routinization** on organization agility, by **increasing** the stability period in the time interval **between** successive changes, driven by a decrease in the time spent **within** that time interval in implementing system changes in support of process changes. Since systems agility can influence both **effects** of ERP assimilation viz. **diffusion** and **routinization** and correspondingly their influence on levels of organizational agility, it implies that systems agility moderates the influence of ERP assimilation on organizational agility. We add this result as an additional hypothesis to validate in the theoretical framework of this paper.

**Hypothesis 3:** Systems agility moderates the net positive impact of ERP assimilation on organizational agility.
The nomological network from Kharabe (2012:1), which serves as the core for the theoretical framework for this paper, along with the key results added as hypotheses to be validated by the research in this paper, is shown in Figure 8.

FIGURE 8
Core Nomological Network

![Core Nomological Network Diagram]

Literature from capabilities-based view (CBV) indicates that dynamic capabilities are a key mechanism for organizations to respond to highly dynamic markets, as well as a source of competitive advantage (Teece et al., 1997). Such dynamic capabilities result in changes to processes within the organization. Organizational knowledge and competencies are considered to be critical for the operationalization of dynamic capabilities, in support of such changes to organizational processes (Eisenhardt & Martin, 2000). Although similar, knowledge and competencies are not identical. Organizational knowledge refers to the sum total of facts, information and experience, both explicitly and tacitly generated within a firm as well as permeated from outside the firm (Matusik &
Hill, 1998). On the other hand, organizational *competence*, while encompassing organizational knowledge, is considered to be more of a dynamic and interactive concept, with it being defined as “*not necessarily directly linked to a specific task but related to the ability to transfer knowledge across tasks*” (Bassellier et al., 2001). Since competence appears to emphasize the ability to deal with complex and dynamic environments (Kanungo & Misra, 1992), it is a more relevant construct than knowledge in its applicability to dynamic markets, which is the focus of this research.

Literature review indicates a multitude of key organizational *competencies* in support of dynamic capabilities in dynamic markets – resource acquisition (Powell et al., 1996), resource allocation (Burgelman, 1996), collaboration (Henderson & Cockburn, 1994), manufacturing (Pisano, 1994), strategic decision making (Fredrickson & Mitchell, 1984), etc. We leveraged qualitative research from Kharabe (2012:2) to identify and understand the specific competencies, which are relevant when organizations are reconciling continually changing business needs with existing ERP systems. A consistent theme which was identified, centered on the competencies governing the working of IT and business divisions in an organization e.g. collaboration between business and IT, “blurring” of the distinction between business and IT, rotation of leadership between business and IT, etc. Combining this insight from Kharabe (2012:2) in alignment with the theoretical framework from Kharabe (2012:1), we identified the following two complementary organizational competencies as the *knowledge conditions* to investigate, under which assimilation levels of innovations like enterprise systems influence organizational agility – a) IT Competence in Business (ITCB) – defined as “*the set of IT-related explicit and tacit knowledge that a business manager possesses that enables him*
or her to exhibit IT leadership in his or her area of business” (Bassellier et al., 2001, p. 159) and b) Business Competence in IT(BCIT) - defined as “the organization-specific knowledge and the interpersonal and management knowledge possessed by IT professionals” (Bassellier & Benbasat, 2004, p. 673)

Sambamurthy et al. (2003) have proposed a theoretical framework incorporating organizational agility, where they have leveraged real-options theory to argue that IT competencies provide a set of digital options which result in increased agility in a firm. They have proposed that one of the key elements of IT competence is IS/business partnership. Bassellier et al. (2001), leveraging the conceptual framework of relationships from Zmud (1998), have proposed that IT competence in business creates a strong relationship between business and IT managers, which increases cross domain activities. Such increased cross domain activities result in increased cooperation leading to stronger IS/business partnership. Bassellier & Benbasat (2004) have provided empirical evidence that higher levels of business competence in IT similarly lead to stronger IS/business relationship. Combining these insights from separate literatures, we theorize that higher levels of both IT competence in business and business competence in IT lead to stronger IS/business relationship, which results in higher levels of IT competence, increased digital options and correspondingly higher levels of organizational agility. Hence, we add the following hypotheses to our research model.

**Hypothesis 4:** ITCB positively impacts organizational agility

**Hypothesis 6:** BCIT positively impacts organizational agility
By definition, higher levels of assimilation of innovations like enterprise systems will have the organizational effect of higher levels of diffusion of such innovations across the organizational projects or work processes as well as higher levels of routinization of the innovation in the activities of those projects and processes. We theorize that higher levels of IT competence in business will enable the routinization of ERP in the work processes of business, through better knowledge in business of the capabilities and usage of ERP technology, as well as of the underlying information technologies. Thus, higher ITCB can lead to higher ERP routinization and correspondingly higher levels in the impact of ERP routinization on organization agility. Similarly, we theorize that higher levels of business competence in IT will enable the diffusion of ERP in the organization through increased knowledge in IT of business goals and strategies, resulting in two outcomes – a) increased unit scope diffusion from existing functional modules of the ERP systems being rolled out by IT more effectively across additional business units and b) increased functional scope diffusion from additional functional modules of ERP being rolled out more effectively by IT to existing business units. Thus, higher BCIT can lead to higher ERP diffusion and correspondingly higher levels in the impact of ERP diffusion on organization agility. Since higher levels of both ITCB and BCIT will amplify the effects of ERP assimilation and correspondingly the impact of ERP assimilation on organizational agility, we add the following hypotheses on the moderating effects of ITCB and BCIT.

**Hypothesis 5: ITCB positively moderates the net positive impact of ERP assimilation on organizational agility.**
Hypothesis 7: BCIT positively moderates the net positive impact of ERP assimilation on organizational agility.

Extending the earlier discussion of higher levels of ITCB and BCIT leading to higher levels of IS/business partnership, we theorize that such higher levels of IS/business partnership will positively influence systems agility, as follows. From the business perspective, higher levels of IS/business partnership will improve business’ capability to proactively take into account changes to information systems while changing business products and strategies, in response to agility challenges. This will result in increased swiftness of changes to the information systems, due to proactive planning at the business end and correspondingly quicker response at the IT end. From the IT perspective, higher levels of IS/business partnership will bring IT closer to business, enable IT to learn from business as well as gather clearer and more accurate requirements of the system changes needed. This will result in increased success of changes to the information systems. Thus higher levels of both ITCB and BCIT will lead to higher levels of IS/business partnership resulting in correspondingly higher swiftness and success of information systems changes. Hence we add the following hypotheses on the direct effects of ITCB and BCIT on systems agility.

Hypothesis 8: ITCB positively impacts systems agility

Hypothesis 9: BCIT positively impacts systems agility

Figure 9 shows the updated nomological network incorporating ERP assimilation, organizational agility, systems agility, ITCB and BCIT. It is to be noted that the net result
of the above theorizing is that ITCB and BCIT have a dual effect on organizational agility – a) a moderating effect on the influence of ERP assimilation on organizational agility and b) a partial mediated effect through systems agility. Since it was not known \textit{a priori}, which of these two effects are stronger on organizational agility, we proceeded to the research design phase with both effects intact in the model.

**FIGURE 9**

Research Model

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**Research Design and Methods**

To validate our hypotheses, we used a sociometric \textit{quantitative} approach and conducted a survey to find out and validate the postulated dual impacts of ITCB and BCIT on organizational agility. The unit of analysis in this study is at a strategic business
unit level. We felt that this was the most appropriate granular level to obtain valid insights of ERP impacts within an organization.

**Operationalization of Constructs**

The scales for most constructs were adapted from existing instruments (Bassellier et al., 2001; Bassellier & Benbasat, 2004; Davis, 2009; Sambamurthy et al., 2007). Necessary additional revisions were done whenever needed given the context of the study.

**Dependent Variable: Organizational agility**

We used the 18-item instrument from Sambamurthy et al. (2007) for measuring organizational agility. It is based on the framework of entrepreneurial agility and adaptive agility of Bharadwaj & Sambamurthy (2005) and was adapted to ensure that the unit of analysis was at a business unit level. Entrepreneurial agility was measured along the dimensions of proactiveness (Miller & Friesen, 1983; Ramanujam & Venkatraman, 1987), preemptiveness (MacMillan, 1983; Sethi & King, 1994) and radical innovation (Miller & Friesen, 1983; Zahra & Covin, 1995). Adaptive agility was measured along the dimensions of reactiveness (Hult et al., 2005; Tracey et al., 1999), resilience (Mallak, 1998; Sheffi & Rice Jr., 2005) and incremental innovation (Skaggs & Huffman, 2003; Subramaniam & Youndt, 2005).

**Independent Variable: ERP Assimilation**

We leveraged the instrument from Liang et al. (2007) which measured ERP assimilation along dimensions of volume, diversity and depth from Zmud & Massetti (1996). Although these dimensions and their associated items from Liang et al. (2007)
address one element in the definition of assimilation viz. *diffusion*, we felt that they do not adequately address the other equally critical component of *routinization* in the definition of assimilation. Hence we consulted with Goodhue (see e.g. Goodhue et al., 2009) to develop an updated scale for measuring ERP assimilation along the three dimensions of *diffusion*, *diversity of routinization* and *depth of routinization*. *Diffusion* was measured on a 15-point scale by gathering objective input on the number of functional modules of the enterprise system implemented in the business unit. *Diversity of routinization* was measured by gathering input on usage of each of the fifteen functional modules in operational, management and decision-making routines of the business unit. The final score was computed on a 5-point scale as a weighted average score across all functional modules, with twice the weightage for management and decision-making routines as compared to the baseline operational routines. Based on qualitative research from Kharabe (2012:2), *depth of routinization* was measured using a nine item scale, as a measure of the extent to which enterprise systems were ‘*embedded in the DNA of the business unit*’.

**Moderating and Mediating variable: Systems Agility**

We adapted the instrument from Davis (2009) to measure systems agility with a four item scale, with appropriate changes to ensure that unit of analysis was at business unit level.
Independent and Moderating variable: IT Competence in Business

We adapted the instrument from Bassellier et al. (2001) to measure IT Competence in Business with a five item instrument, with appropriate changes to ensure that unit of analysis was at business unit level.

Independent and Moderating variable: Business Competence in IT

We adapted the instrument from Bassellier & Benbasat (2004) to measure Business Competence in IT with a four item instrument, with appropriate changes to ensure that unit of analysis was at business unit level.

Control Variables

For organizational agility, we controlled for the following four variables at the business unit level, because of their potential impact on organizational agility as suggested by extant literature (Liang et al., 2007; Lu & Ramamurthy, 2011; Tallon & Pinsonneault, 2011).

Industry type. This was measured in categories of Consumer Products, Industrial Products, Services, Government/Non-profit and Others.

Size: Revenues. This was measured in mutually exclusive intervals of <$300M, <$1B, <$5B, <$10B and >$10B.

Size: Employees. This was measured in mutually exclusive intervals of 1-499; 500-1,999; 2,000-4,999 and 5,000+ employees.

Age. This was defined as the number of years since the founding of the business unit and was measured in mutually exclusive intervals of 0-4; 5-9; 10-19; 20-49 and 50+ years.
For systems agility, we controlled only for business unit size (employees and revenues) and business age, since literature review did not provide any insight that industry type may influence systems agility.

**Instrument Development**

As far as possible, we used existing instruments with good established psychometric properties to ensure measurement reliability and validity. In scale development and contextualization we followed the suggestions from DeVellis (2003). Since the items for at least one key construct in this research were not adapted from existing instruments, a two-step process was followed to ensure validity and reliability of these modified or self-developed items. First, the items were distributed to three well-know management and IS academic researchers and a PhD student, all of whom had expertise in the specific research area of this paper. The items were updated based on their feedback on face validity and construct validity of the instrument. Second, a pilot survey of the instrument was conducted with 50 respondents in one large publicly traded $3 billion organization in the US. The pilot was a cross-sectional survey with respondents identified across four business units and in positions of executive responsibility, as well as having knowledge of both business and IT aspects of their business unit. Exploratory factor analysis (EFA) was done on the pilot data and single factor loadings for each construct were found to be acceptable. Reliability analysis based on Cronbach’s alpha revealed that all constructs had acceptable values (>0.70), except resilience (0.7) and reactiveness (0.58). Based on subsequent analysis of inter-item correlation matrix, items of resi3 and reac3 were reworded to improve reliability. In addition, based on feedback
from pilot respondents on the length of the survey, some constructs not core to the research of this paper (project management agility, IT competence in IS, social capital) were dropped. Other than control variables and objective items, the finalized instrument had all scales defined as seven-point Likert scales and is included in Appendix A.

**Data Collection**

The finalized instrument was sent out as a cross-sectional web-survey to approximately 2000 organizations in the US, who have all implemented SAP ERP solution. SAP is the largest vendor of ERP solutions in the world. All of the organizations were identified through their membership in a US-based non-profit association of companies in US who have implemented SAP ERP. The survey respondents in the organizations were targeted from a pool of both business and IT executives. Respondents were assured of complete confidentiality and did not receive any remuneration for their participation. The link to the web-survey was emailed by the user association to the organizations. A follow-up email was sent two weeks after the initial email, as a reminder. After exclusion of cases with missing data, we had a final sample size of 215 cases. Since the link to the web-survey was emailed by a trade group to the organizations, it was not possible to directly contact the organizations to measure non-response bias. However, emails received by the user association from the non-respondents indicated that the conference travels as well as organizational policies against participation were the key reasons for not responding. Characteristics of the respondents are provided in Table 10.
### TABLE 10

**Respondent Characteristics**

#### Business Unit – Industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Products</td>
<td>95</td>
<td>44%</td>
</tr>
<tr>
<td>Industrial Products</td>
<td>39</td>
<td>18%</td>
</tr>
<tr>
<td>Services</td>
<td>45</td>
<td>21%</td>
</tr>
<tr>
<td>Govt/Non-profit</td>
<td>10</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>25</td>
<td>12%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>215</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

#### Business Unit – Employees

<table>
<thead>
<tr>
<th>Employees Range</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-499</td>
<td>21</td>
<td>10%</td>
</tr>
<tr>
<td>500-1999</td>
<td>24</td>
<td>11%</td>
</tr>
<tr>
<td>2000-4999</td>
<td>30</td>
<td>14%</td>
</tr>
<tr>
<td>5000-9999</td>
<td>68</td>
<td>32%</td>
</tr>
<tr>
<td>10,000+</td>
<td>73</td>
<td>34%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>215</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

#### Business Unit – Revenues

<table>
<thead>
<tr>
<th>Revenues Range</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; $300 million</td>
<td>29</td>
<td>13%</td>
</tr>
<tr>
<td>&lt; $1 billion</td>
<td>30</td>
<td>14%</td>
</tr>
<tr>
<td>&lt; $5 billion</td>
<td>94</td>
<td>44%</td>
</tr>
<tr>
<td>&lt; $10 billion</td>
<td>22</td>
<td>10%</td>
</tr>
<tr>
<td>&gt;= $10 billion</td>
<td>40</td>
<td>19%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>215</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
**Business Unit – Age**

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4 years</td>
<td>8</td>
<td>4%</td>
</tr>
<tr>
<td>5-9 years</td>
<td>19</td>
<td>9%</td>
</tr>
<tr>
<td>10-19 years</td>
<td>31</td>
<td>15%</td>
</tr>
<tr>
<td>20-49 years</td>
<td>54</td>
<td>25%</td>
</tr>
<tr>
<td>50+ years</td>
<td>102</td>
<td>47%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>215</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**Measurement model**

We used SPSS for univariate and multivariate analysis of the items, to ensure that it was appropriate for subsequent factor analysis. Normality tests based on skewness and kurtosis statistics showed that normality was within normal limits. Hence no transformation efforts were pursued. Additionally, visual inspection for normality, skewness and kurtosis using histogram, Q-Q plot and box-plot for each item confirmed that normality, skewness and kurtosis seemed within reasonable limits. Similarly, the data was assessed for multicollinearity, homoscedasticity and outliers, all of which were within limits. Appropriateness for factor analysis was assessed by examining Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (excellent at 0.913) and Bartlett’s test statistic for sphericity, which was significant at the 0.001 level.

An exploratory factor analysis (EFA) using principal axis factoring with Promax rotation resulted in ten factors, with each item loading on its factor with a value greater than 0.4 and all cross-load differences were greater than 0.2. The total variance explained
by these ten factors was 71.6%. Even though the number of factors in EFA was in line with the number of factors from the theoretical model, it was noticed that the sub-construct of preemptiveness (pree) loaded with the sub-construct of proactiveness (proc), within the construct of organizational agility (oa), while the items1-3 within the construct of ERP assimilation (erpa) loaded as a separate factor. It was noted for future analysis that preemptiveness could have issues of discriminant validity. No items or sub-constructs were dropped for subsequent CFA. It was decided to start with full measurement model (based on theory) without any deletions, but keeping in mind the above observation.

Confirmatory Factor Analysis (CFA) was carried by incorporating all the ten constructs and the associated items. Through an iterative process, appropriate error covariance relationships were added as well as items deleted (Byrne, 2009). Four items (inci3, sar4, resi2, itcb1) were dropped from the CFA model, leaving a total of 38 items in the model. The number of cases (215) exceeded the minimum requirements of 5 times the number of items (5 x 38 = 190), hence data sample size was considered adequate. The overall model fit for the final CFA model was good (CMIN/DF = 1.578, CFI = .95, SRMR = 0.0533 and RMSEA = .052 (LO = .046, HI = .058, PCLOSE = .295)) (Byrne, 2009)

For all constructs, both Cronbach’s alpha and composite reliability was greater than the threshold of 0.7, thus confirming the theorized construct structure as well as validating that the corrections made for reliability improvement during pilot survey were relevant. All constructs showed excellent convergent validity with CR > AVE and AVE > 0.5 (Fornell & Larcker, 1981). In addition, all constructs also showed high discriminant
validity with MSV < AVE and ASV < AVE. Table 11 shows reliability and validity of final constructs. The inter-factor correlations for the final constructs are included in Appendix B.

### TABLE 11

**Reliability and Validity of Constructs**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Sub-Construct</th>
<th>CR</th>
<th>AVE</th>
<th>MSV</th>
<th>ASV</th>
<th>Cronbach's Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business Competence in IT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proactiveness</td>
<td></td>
<td>0.936</td>
<td>0.830</td>
<td>0.624</td>
<td>0.250</td>
<td>0.899</td>
</tr>
<tr>
<td>Preemptiveness</td>
<td></td>
<td>0.832</td>
<td>0.625</td>
<td>0.624</td>
<td>0.266</td>
<td>0.824</td>
</tr>
<tr>
<td>Radical Innovation</td>
<td></td>
<td>0.888</td>
<td>0.726</td>
<td>0.524</td>
<td>0.265</td>
<td>0.881</td>
</tr>
<tr>
<td>Reactiveness</td>
<td></td>
<td>0.903</td>
<td>0.756</td>
<td>0.531</td>
<td>0.357</td>
<td>0.898</td>
</tr>
<tr>
<td>Resilience</td>
<td></td>
<td>0.716</td>
<td>0.562</td>
<td>0.371</td>
<td>0.191</td>
<td>0.740</td>
</tr>
<tr>
<td>Incremental Innovation</td>
<td></td>
<td>0.935</td>
<td>0.877</td>
<td>0.371</td>
<td>0.219</td>
<td>0.900</td>
</tr>
<tr>
<td><strong>ERP Assimilation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systems Agility</td>
<td></td>
<td>0.910</td>
<td>0.513</td>
<td>0.375</td>
<td>0.204</td>
<td>n.a.</td>
</tr>
<tr>
<td><strong>IT Competence in Business</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.942</td>
<td>0.803</td>
<td>0.317</td>
<td>0.136</td>
<td>0.943</td>
</tr>
</tbody>
</table>

Since the data was collected using a single method from a single source the possibility of having introduced common method bias cannot be eliminated. Harman’s single-factor test (Podsakoff et al., 2003) showed that the first factor explained 37.8% of
total variance (< 50%). A common marker analysis was carried out showing the presence of 6.76% common method variance. This is within acceptable threshold for IS research (Malhotra et al., 2006). A nested model comparison between the final measurement model and the common marker model was not significant (p=0.437), indicating that common method effect was not significant for the overall measurement model.

**Structural Analyses**

A structural equation model (SEM) was built in AMOS, as per the causal model in Figure 9. The final trimmed model was created through reviewing modification indices, adding covariance paths where theoretically justified, and trimming insignificant paths when necessary (Byrne, 2009). The final model had fit characteristics of: CMIN/DF = 2.948, CFI = 0.936, SRMR = 0.061, RMSEA = 0.09, (LO = 0.08, HI = 0.11, PCLOSE = 0.00).

**Findings**

The final structural equation model shows that ERP assimilation (β=0.135) is significant as a determinant of organizational agility (p < 0.001). Since β is positive, it implies that ERP assimilation has a net positive influence on organizational agility. Hence **Hypothesis 1 is supported**. Systems agility (β=0.379) was also found to be significant as a determinant of organizational agility at the p < 0.001 level. Since β is positive, **Hypothesis 2 is supported**. The interaction term of systems agility and ERP assimilation (β=0.125) was found to be significant at the p < 0.01 level. Since β is positive, it implies that systems agility *positively moderates* the effect of ERP
assimilation on organizational agility. Hence **Hypothesis 3 is supported**. Thus all three hypotheses from Kharabe (2012:1) continue to be valid in this research model.

ITCB was not found to be significant as a determinant of organizational agility at p < 0.1 level. **Hence Hypothesis 4 is not supported**. The interaction term of ITCB and ERP assimilation ($\beta=-0.106$) was found to be significant at the p < 0.01 level. This implies that ITCB moderates the effect of ERP assimilation on organizational agility. However since $\beta$ is negative, it implies that ITCB does not positively moderate the influence of ERP assimilation on organizational agility, as hypothesized. **Hence Hypothesis 5 is partially supported**.

**Hypothesis 6 is supported**. The interaction term of BCIT and ERP assimilation was not significant at the p < 0.1 level. **Hence Hypothesis 7 is not supported**. ITCB ($\beta=0.377$) was found to be significant as a determinant of systems agility at the p < 0.001 level. Since $\beta$ is large, **Hypothesis 8 is strongly supported**. Similarly, BCIT ($\beta=0.432$) was also found to be significant as a determinant of systems agility at the p < 0.001 level. Since $\beta$ is large, **Hypothesis 9 is also strongly supported**.

Overall, the model explained 49.2% of the variance of systems agility and 49.9% of the variance of organizational agility. None of the control variables were found to be significant in determining organizational agility or systems agility. The results are summarized in Table 12.
### TABLE 12

Results of Hypothesized Relationships

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Supported?</th>
<th>Estimate</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>ERP assimilation net positively impacts organizational agility</strong></td>
<td>Yes</td>
<td>0.135</td>
<td>***</td>
</tr>
<tr>
<td>2. <strong>Systems agility positively impacts organizational agility</strong></td>
<td>Yes</td>
<td>0.379</td>
<td>***</td>
</tr>
<tr>
<td>3. <strong>Systems agility moderates the net positive impact of ERP assimilation on organizational agility</strong></td>
<td>Yes</td>
<td>0.125</td>
<td>0.002</td>
</tr>
<tr>
<td>4. <strong>ITCB positively impacts organizational agility</strong></td>
<td>No</td>
<td>n.a.</td>
<td>n.s.</td>
</tr>
<tr>
<td>5. <strong>ITCB positively moderates the net positive impact of ERP assimilation on organizational agility.</strong></td>
<td>Partially</td>
<td>-0.106</td>
<td>0.006</td>
</tr>
<tr>
<td>6. <strong>BCIT positively impacts organizational agility</strong></td>
<td>Yes</td>
<td>0.122</td>
<td>0.008</td>
</tr>
<tr>
<td>7. <strong>BCIT positively moderates the net positive impact of ERP assimilation on organizational agility.</strong></td>
<td>No</td>
<td>n.a.</td>
<td>n.s.</td>
</tr>
<tr>
<td>8. <strong>ITCB positively impacts systems agility</strong></td>
<td>Yes</td>
<td>0.377</td>
<td>***</td>
</tr>
<tr>
<td>9. <strong>BCIT positively impacts systems agility</strong></td>
<td>Yes</td>
<td>0.432</td>
<td>***</td>
</tr>
</tbody>
</table>

The interaction between systems agility and ERP assimilation in its impact on organizational agility is visually illustrated in the interaction plot in Figure 10.
FIGURE 10
Interaction Plot – Systems Agility – Current Research Model

FIGURE 11
For comparison, the corresponding interaction plot for the moderating effects of systems agility from Kharabe (2012:1) is shown in Figure 11. The interaction plot for the current research model incorporating the effects of organizational knowledge and competencies is very similar to that from Kharabe (2012:1). At lower levels of systems agility, organizational agility appears to be visually even more flat with increase in ERP assimilation. At higher levels of systems agility, organizational agility continues to increase with increase in ERP assimilation. However the slope of this increase is significantly larger than in Kharabe (2012:1), implying that systems agility has an even larger amplifying effect in the impact of ERP assimilation on organizational agility (on top of those achieved by system agility directly), when organizational knowledge effects are part of the research model. Thus, systems agility continues to be a key organizational ingredient, which acts as a larger catalyst in enabling the positive impact of enterprise systems on organizational agility.

The interaction between ITCB and ERP assimilation in its impact on organizational agility is visually illustrated in the interaction plot in Figure 12.
FIGURE 12
Interaction Plot – ERP Assimilation and IT Competence in Business

The results from the interaction plot are both interesting and surprising. The key conclusions are as follows.

When an organization has low IT competence in business, with higher ERP assimilation, organizational agility increases. This implies that even if business has low IT competence in business, it is not a barrier to the organization having higher agility with higher levels of ERP assimilation.

However, when an organization has high IT competence in business and high ERP assimilation, we see very surprising results. Higher ERP assimilation not only does not result in higher organizational agility, but on the contrary organizational agility decreases slightly with higher ERP assimilation. This implies that higher IT competence
in business is potentially a *barrier* to the positive influence of ERP systems on organizational agility at higher ERP assimilation.

In addition, when an organization has lower levels of ERP assimilation, the above interaction plot shows that *higher* levels of IT competence in business result in *higher* organizational agility. This seems to imply that *higher* levels of IT competence in business are desirable in organizations with *lower* levels of ERP assimilation, since the higher IT knowledge present in business can potentially help the business units in responding *faster* to externally imposed agility challenges as well as make up for the lower ERP assimilation which could otherwise have resulted in lower agility, in the absence of higher IT competence in business.

**Discussion**

Prior research has shown that apart from enterprise systems improving productivity and efficiency in organizations (Goodhue et al., 2009), they also positively influence organizational agility, with systems agility serving as a catalyst in amplifying such influence (Kharabe, 2012:1). The focus of the research in this paper was twofold - to validate the results from Kharabe (2012:1) as well as to extend the work from Kharabe (2012:1), to understand the *knowledge context* in which enterprise systems impact organizational agility. In order to achieve these objectives, we leveraged the model from Kharabe (2012:1) to embed ERP assimilation, organizational agility, systems agility, IT competence in business (ITCB) and business competence in IT (BCIT) in a nomological network with systems agility moderating the impact of ERP assimilation on organizational agility. In addition, both ITCB and BCIT have dual effects on
organizational agility – a moderating effect on the influence of ERP assimilation on 
organizational agility as well as systems agility having a partially mediating effect on the 
influence of ITCB and BCIT on organizational agility.

Our findings validate the results from Kharabe (2012:1) that both ERP 
assimilation and systems agility have a positive direct effect on organizational agility. The strengths of such effects (β equal to 0.135 and 0.379 for ERP assimilation and 
systems agility respectively) are almost identical in the knowledge-based research model 
of this paper, to those in Kharabe (2012:1). In addition to the strong direct effect of 
systems agility on organizational agility, this paper also validates the key role of systems 
agility in amplifying the effect of ERP assimilation on organizational agility.

Interestingly, the effect of the interaction between systems agility and ERP assimilation 
on organizational agility (β =0.125) in this paper is more than double of that in Kharabe 
(2012:1) (β =0.057). One interpretation of this result is that when knowledge effects are 
accounted for in the model, the catalytic effect of systems agility in boosting the 
influence of ERP assimilation on agility is even stronger than that understood in earlier 
models.

Kharabe (2012:1) uncovered the critical enabling role of systems agility in 
answering the paradox of whether enterprise systems promote or hinder organizational 
agility. However, Kharabe (2012:1) stopped short of answering the next set of logical 
questions – What are the antecedents of this catalyst of systems agility? What are the 
levers that can be managerially pressed to potentially increase systems agility? The 
findings of this paper answer these questions. Both IT competence in business (ITCB) 
and business competence in IT (BCIT) have very strong direct effects (β equals 0.337 and
0.445 respectively) on systems agility, thus extending on the work of Kharabe (2012:1) to additionally identify them as antecedents to systems agility. It also validates the qualitative work from Kharabe (2012:2), in confirming that ITCB and BCIT were correctly identified and observed as competencies relevant in organizations, in the context of enterprise systems and agility. Additionally, it also confirms our theorizing that higher levels of ITCB and BCIT in an organization can increase IS/business partnership leading to factors resulting in increased swiftness and success of information system changes.

When conceptualizing the strong direct effects of ITCB (β = 0.377) and BCIT (β = 0.432) on systems agility and the strong direct effect of systems agility (β = 0.388) on organizational agility, in tandem with the results of direct effects of both ITCB and BCIT on organizational agility, one reaches the interesting conclusion that systems agility fully mediates the strong effects of ITCB and partially mediates the strong effect of BCIT, on organizational agility. This result extends the work from Kharabe (2012:1) which identified the enabling role of systems agility in the impact of assimilation of complex innovations like enterprise systems on agility, by also additionally identifying the singular role of systems agility in enabling the strong impact of organizational competencies like ITCB and BCIT on organizational agility.

The interaction term of ITCB and ERP assimilation was found to be significant in its impact on organizational agility. Hence this result confirms our theorizing logic that IT competence in business influences the routinization of ERP in the work processes of business and correspondingly the impact of ERP assimilation on organizational agility, through better knowledge in business of the capabilities and usage of ERP technology.
However, the interaction plot of this moderation effect suggests that excessive knowledge in business is potentially a barrier to the positive influence of ERP systems on organizational agility at higher ERP assimilation. There are three potential explanations for this highly interesting and surprising result. First, IT support for ERP systems typically tends to be centralized in a firm, while usage of ERP systems is typically decentralized at the business unit level. Under the combined effect of higher IT competence and excessive IT knowledge in business at the business unit level, as well as higher ERP assimilation throughout the organization including at the business unit level, potential conflicts may arise between centrally administered IT system development capabilities and the agility responses demanded by the business unit based on high IT knowledge, leading to mis-prioritization and mis-allocation of resources and hence lower agility. Second, higher levels of IT competence in business in organizations with higher capability of innovation assimilation could be giving rise to a phenomenon of ‘IT substitute”, where the business units may be substituting IT units with in-house IT competencies or developing IT workarounds. Such in-house IT competencies may not be of the same caliber as those provided by the IT unit and the workarounds may not be scalable, resulting in lowered organizational agility. Third, higher ITCB beyond a threshold level may be leading to organizational hubris (Johnson et al., 2010), resulting in lower collaboration and poorer decision-making, with a corresponding decrease of agility in dynamic environments.

The interaction term of BCIT and ERP assimilation was not found to be significant in its impact on organizational agility. Hence the result cannot confirm our theorizing logic that higher levels of Business Competence in IT (BCIT) will have an
amplifying effect on the influence ERP diffusion on agility, through increased knowledge in IT of business goals and strategies driving unit scope diffusion and functional scope diffusion. Similarly the direct effect of ITCB on organizational agility was not found to be significant, thus not supporting our theorizing logic that a) higher levels of ITCB increases IS/business partnership, resulting in b) greater digital options, leading to c) higher organizational agility. However the result of strong direct effects of ITCB and BCIT on systems agility, based on a similar theorizing logic, provides credence to part (a) of the previous theorizing logic that higher levels of ITCB and BCIT increase IS/business partnership. Hence the primary potential explanations to this breakdown in the theorizing logic appear to be in steps (b) and (c). Future empirical research on digital options theoretical framework can perhaps provide insights into these results.

Organizational competencies like ITCB and BCIT have a dual effect on organizational agility – through a mediator like systems agility and as a moderator in the influence of ERP assimilation on agility. An interesting observation is that the total influence of ERP assimilation on organizational agility is lower than the sum total of the influence of ITCB and BCIT on organizational agility. One possible explanation for this gap is that the construct of systems agility encompasses swift and successful changes to all information systems in the organization. On the other hand, the construct of ERP assimilation encompasses assimilation of one specific technology innovation, out of a vast multitude of potential technology innovations in the organization. Hence, we conjecture that if one were to sum up the influence of assimilation of all technology innovations on organizational agility, it would explain a larger portion of the earlier identified gap in impact on organizational agility. It would also imply that if we apply the
calculus metaphor of limits to this outcome, we may get the result that in the limiting condition of innovation assimilation approaching all technology innovations, organizational agility would approach maximal value. However, the limiting condition of innovation assimilation approaching all technology innovations leads to the conceptual result of an integrated enterprise architecture. Hence it implies that higher levels of enterprise architecture will result in higher organizational agility, which is an alternate derivation of similar strategy from enterprise architecture literature (Ross et al., 2006).

Finally, the results of the research in this paper confirm from Kharabe (2012:1) that innovation assimilation continues to provide a valid theoretical lens, to not only understand and explain the effects of complex process-oriented innovations like enterprise systems on organizational agility, but also to give insights into the conditions under which complex innovations influence organizational agility, including specific knowledge conditions like the dual effect mechanisms of organizational competencies on organizational agility. Hence our work provides a foundation for future researchers for application of innovation assimilation frameworks to other forms and types of innovations, especially in the context of dynamic and turbulent organizational environments.

**Limitations**

Some of the limitations and key assumptions for the research in this paper are as follows. The data collected were limited to organizations in the United States. Hence the findings may not be generalizable outside USA. The organizations selected for data collection have all implemented one specific ERP solution viz. SAP. Hence the findings
may not be generalizable to organization with other ERP solutions and would need further study. In addition, newer versions of ERP systems offering Web services or cloud based services may change the configurability of ERP systems such that assimilation effects accrue at a different pace than those captured in this study. To participate in data collection, organizations were randomly selected by a non-profit trade group in USA comprising of members who have implemented SAP. It is not known if the request from an association explicitly introduces any selection bias while identifying the organizations to participate in the survey. Since the link to the web-survey was emailed by a third-party non-profit association to the organizations directly, it is not possible to empirically measure or validate the presence of non-response bias or conduct wave tests to compare late or early respondents (Armstrong & Overton, 1977).

**Implications for Practice and Future Research**

Prior research (Kharabe, 2012:1) has shown that that IS managers need to specifically focus on inculcating systems development dynamic capabilities in the organization, since the speed of such systems development capabilities (as exemplified by the concept of systems agility) not only has a direct effect on making the organization agile, but in addition it has an amplifying effect in enabling the role of enterprise systems to influence organizational agility. However the question on managerially actionable antecedents to systems agility was left open in prior research. The research in this paper indicates that higher levels of two key organizational competencies of IT competence in business (ITCB) and business competence in IT (BCIT) lead to significantly higher levels of systems agility. Hence executive management needs to additionally focus on
developing and inculcating these two competencies in the business units and IT units of the organization respectively.

Since organizational competencies require costs and time to develop as well as can face potential change barriers, C-level management needs to evolve beyond simply supporting adaption and deployment of enterprise-wide innovation technologies, to taking an active leadership role in supporting change management programs and procedures, to aid development of higher levels of IT competence in business and business competence in IT. Apart from well-known frameworks of change management, qualitative research from Kharabe (2012:2) suggests two additional possible mechanisms for C-level executives to use as guidance for effective change management in support of higher levels of ITCB and BCIT – rotation of leadership between business and IT, as well as relevant IT units reporting directly into business.

At the same time, business unit managers need to be aware that our research seems to suggest that specifically in the cases of IT competence in business (ITCB), higher levels of ITCB can potentially hinder organizational agility, due to either the effect of ‘IT substitute’ and/or organizational hubris. The threshold of the level at which ITCB can potentially be disruptive to agility may be dependent on multiple factors such as level of centralization of IT support vis-à-vis level of decentralization of business units, level of impact of ITCB on systems agility vis-à-vis level of impact of ITCB on influence of ERP assimilation on agility, ERP assimilation maturity, agility environment, etc. Since it would be difficult for management to a priori determine precise levels of disruptive ITCB, it is advisable for management to be generally aware of symptoms of disruptive ITCB levels, such as mis-prioritization or mis-allocation of resources between business
and IT, conflicts between decentralized business units on centralized IT support provided for technology innovations, as well as excessive levels of *IT substitute effect* in decentralized business units.

Our research indicates multiple areas for further research. First, our research indicates an asymmetric effect in the moderating influence of BCIT vis-à-vis ITCB on the impact of ERP assimilation on organizational agility, as well as an absence of direct effects of ITCB on organizational agility. Additional research may be undertaken to empirically re-validate as well as identify the valid *underlying* theoretical mechanisms for explaining these effects. Second, our research seems to suggest that the level of architecture integration between multiple technology innovations may influence organizational agility. Hence we plan to further pursue this direction by analyzing the effects of the configurations of modules on organizational agility. Third, we plan to study the influence of the environmental turbulence on the nomological network developed in this paper. Finally, we believe that analyzing the effects of innovation assimilation on the constituent components within organizational agility (e.g. entrepreneurial agility, adaptive agility, etc), will provide a rich insight into the mechanisms of innovation assimilation. We also plan to study this next level of granularity in future research.
## Appendix A - Constructs and Items

<table>
<thead>
<tr>
<th>Construct (label)</th>
<th>Dimension (label)</th>
<th>Sub-Dimension (label)</th>
<th>Item</th>
</tr>
</thead>
</table>
| Org. agility (oa) | Entrepreneurial agility (ea) | Proactiveness (PROC) | PROC1. Anticipate new business opportunities  
PROC2. Seek new business opportunities  
PROC3. Seek novel approaches to future market needs |
| | Preemptiveness (PREE) | PREE1. Be the first to market with new business approaches (or models)  
PREE2. Develop new standards and practices in the industry  
PREE3. Preempt imitators through marketing actions |
| | Radical innovation (RADI) | RADI1. Seek high-risk projects with chances of high return  
RADI2. Support business experimentation despite uncertain returns  
RADI3. Commit resources to radical changes that can potentially transform markets and competition |
| | Reactiveness (REAC) | REAC1. Rapidly react to emerging opportunities in customer needs  
REAC2. Rapidly react to emerging opportunities in markets  
REAC3. Rapidly react to emerging opportunities in new products and services |
| Adaptive agility (aa) | Resilience (RESI) | RESI1. Rapidly respond to natural threats (e.g., natural disaster)  
RESI2. Rapidly respond to competitive threats (e.g., competitor’s price change and new marketing campaign)  
RESI3. Rapidly respond to operational threats (e.g., production disruption) |
| | Incremental innovation (INCI) | INCI1. Adapt existing business models  
INCI2. Adapt existing business processes  
INCI3. Quickly adopt best practices used by others |
<table>
<thead>
<tr>
<th>Construct (label)</th>
<th>Dimension (label)</th>
<th>Sub-Dimension (label)</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERP Assimilation (erpa)</td>
<td>Diffusion (diff)</td>
<td></td>
<td>Which of the following modules of SAP ERP solution have been implemented for your business unit/division?</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>FI-CO (Financial Accounting/Controlling)</td>
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<td></td>
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<td></td>
<td>HR (Human Resource)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>SD (Sales and Distribution)</td>
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<tr>
<td></td>
<td></td>
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<td>MM (Materials Management)</td>
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<td></td>
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<td></td>
<td>PP (Production Planning)</td>
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<td></td>
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<td></td>
<td>PM (Plant Maintenance)</td>
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<td></td>
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<td></td>
<td>QM (Quality Management)</td>
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<td></td>
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<td></td>
<td>BW (Business Warehousing)</td>
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<td></td>
<td></td>
<td></td>
<td>LIS (Logistics Information System)</td>
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<td></td>
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<td></td>
<td>IS (Industry Solutions e.g. Retail, AFS)</td>
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<td></td>
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<td></td>
<td>CRM (Customer Relationship Management)</td>
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<td>PLM (Product Life Cycle Management)</td>
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<td>SCM (Supply Chain Management)</td>
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<td>SRM (Supplier Relationship Management)</td>
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<td></td>
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<td></td>
<td>SEM (Strategic Enterprise Management)</td>
</tr>
<tr>
<td>Diversity of Routinization (r_di)</td>
<td></td>
<td></td>
<td>For those modules implemented, please also identify what they are used for in your business unit/division.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Used for Operations</td>
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<td></td>
<td></td>
<td></td>
<td>Used for Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Used for Decision-making</td>
</tr>
<tr>
<td>Construct (label)</td>
<td>Dimension (label)</td>
<td>Sub-Dimension (label)</td>
<td>Item</td>
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</tr>
<tr>
<td>ERP Assimilation (erpa)</td>
<td>Depth of Routinization (r_de)</td>
<td></td>
<td>Item1 We expect the ERP system will provide future opportunities for improving the way we do business.</td>
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<tr>
<td></td>
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<td>Item2 We see the ERP system as providing additional opportunities for improving the unit’s effectiveness.</td>
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<td></td>
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<td>Item3 We see the ERP system not just as a replacement for our old systems but also as a new platform that can provide valuable new capabilities.</td>
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<td>Item4 We actively look for new ways of using the ERP system to improve our effectiveness.</td>
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<td></td>
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<td>Item5 We encourage our people to further explore and learn the ERP system so that new ways of utilizing it can be found.</td>
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<td>Item6 We devote resources to exploring the ERP system to find new ways to leverage its power.</td>
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<td></td>
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<td>Item7 We continue to find new ways of taking advantage of the ERP system to improve the way we do business.</td>
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<td></td>
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<td>Item8 We are still discovering new ways of using the ERP system to get business benefits.</td>
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<td></td>
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<td>Item9 The ERP continues to gives us new opportunities to improve our effectiveness.</td>
</tr>
<tr>
<td>Construct (label)</td>
<td>Dimension (label)</td>
<td>Sub-Dimension (label)</td>
<td>Item</td>
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</tr>
<tr>
<td>Systems Agility</td>
<td>Systems Agility (sar)</td>
<td></td>
<td>SAR1 - We are successful in rapidly changing our information systems in response to changing business needs. SAR2 - The information systems in place within our business unit enable our capability to make critical changes quickly in response to changing business needs. SAR3 - Within our business unit, we can quickly change our information systems in response to changing business needs. SAR4 - In general, our business unit's IT group can make needed system changes in a timely manner.</td>
</tr>
<tr>
<td>Controls</td>
<td>Industry (bu_industry)</td>
<td></td>
<td>Consumer Products, Industrial Products, Services, Govt/Non-Profit, Others</td>
</tr>
<tr>
<td></td>
<td>Size- # employees (bu_employees)</td>
<td></td>
<td>1-499; 500-1,999; 2,000-4,999, 5,000+</td>
</tr>
<tr>
<td></td>
<td>Size- revenues (bu_revenues)</td>
<td></td>
<td>&lt;$300M, &lt;$1B, &lt;$5B, &lt;$10B, &gt;$10B</td>
</tr>
<tr>
<td></td>
<td>Age – years since founding of this business unit (bu_age)</td>
<td></td>
<td>0-4; 5-9; 10-19; 20-49,50+</td>
</tr>
<tr>
<td>Construct (label)</td>
<td>Dimension (label)</td>
<td>Sub-Dimension (label)</td>
<td>Item</td>
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<tr>
<td>Business Competence in IT (bcit)</td>
<td></td>
<td></td>
<td>BCIT1 Rate your IT organization’s level of knowledge of the business unit’s external environment (e.g., government, competitors, suppliers, and customers)</td>
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<tr>
<td></td>
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<td>BCIT2 Rate your IT organization’s level of knowledge of the goals and objectives of the business unit as a whole</td>
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<td></td>
<td>BCIT3 Rate your IT organization’s level of knowledge of the core capabilities of the business unit</td>
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<td></td>
<td>BCIT4 Rate your IT organization’s level of knowledge of the key factors that must go right for the business unit to succeed</td>
</tr>
<tr>
<td>IT Competence in Business (itchb)</td>
<td></td>
<td></td>
<td>ITCB1 What is your business unit’s general knowledge of ERP systems?</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>ITCB2 What is your business unit’s general knowledge of applying IT functionality to business needs?</td>
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<td></td>
<td>ITCB3 What is your business unit’s general knowledge of the IT technical infrastructure?</td>
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<td></td>
<td>ITCB4 What is your business unit’s general knowledge of databases supporting the business?</td>
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<td></td>
<td></td>
<td></td>
<td>ITCB5 What is your business unit’s general knowledge of the network systems supporting the business?</td>
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### Appendix B - Inter-Factor Correlations

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<tbody>
<tr>
<td>Business Competence in IT</td>
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</tr>
<tr>
<td>Proactiveness</td>
<td></td>
<td>0.309</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Preemptiveness</td>
<td>0.324</td>
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<td>0.790</td>
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<td></td>
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<tr>
<td>Radical Innovation</td>
<td>0.357</td>
<td>0.623</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Reactiveness</td>
<td>0.502</td>
<td>0.631</td>
<td>0.729</td>
<td>0.695</td>
<td></td>
<td></td>
<td>0.870</td>
<td></td>
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<tr>
<td>Resilience</td>
<td>0.327</td>
<td>0.404</td>
<td>0.400</td>
<td>0.386</td>
<td>0.567</td>
<td></td>
<td>0.750</td>
<td></td>
<td></td>
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<tr>
<td>Incremental Innovation</td>
<td>0.344</td>
<td>0.462</td>
<td>0.377</td>
<td>0.435</td>
<td>0.600</td>
<td>0.609</td>
<td></td>
<td></td>
<td></td>
<td>0.937</td>
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<tr>
<td>ERP Assimilation</td>
<td>0.424</td>
<td>0.366</td>
<td>0.331</td>
<td>0.450</td>
<td>0.518</td>
<td>0.474</td>
<td>0.462</td>
<td>0.716</td>
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<tr>
<td>Systems Agility</td>
<td>0.582</td>
<td>0.392</td>
<td>0.372</td>
<td>0.455</td>
<td>0.660</td>
<td>0.416</td>
<td>0.518</td>
<td>0.612</td>
<td></td>
<td>0.895</td>
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<tr>
<td>IT Competence in Business</td>
<td>0.466</td>
<td>0.285</td>
<td>0.249</td>
<td>0.333</td>
<td>0.406</td>
<td>0.222</td>
<td>0.308</td>
<td>0.354</td>
<td>0.563</td>
<td>0.896</td>
</tr>
</tbody>
</table>
CHAPTER 5 – CONCLUSION

Summary of Research Findings

This dissertation originated with the observation that over the last two decades, firms have operated in business environments which have been characterized by various flux metaphors that appear to have been borrowed from physics, such as dynamic, turbulent, high-velocity and increased acceleration. In response to this environment, firms have faced the imperative to be nimble and agile. At the same time, driven by globalization, increased competition and reduced margins, firms have simultaneously focused on increased efficiency, reduced costs and higher productivity in their operations. One primary tool in their arsenal to address the need for higher efficiency has been the large-scale and wide-spread adoption of information system in general and enterprise systems in particular (Stedman, 1999; Stein, 1999). Although a topic of furious debate until recently amongst scholars, practitioners and sometimes even the general public on whether information technologies cause increased productivity or whether higher productivity firms invest more in information technologies (Brynjolfsson & Hitt, 2000), the dialectic no longer remains unresolved. Recent research (Aral et al., 2006) has empirically shown that enterprise systems (and hence information systems, since enterprise systems form a significant portion thereof) have been a significant and causal source of increased productivity and efficiency in firms.

However, despite these dual transformation forces – need to be agile and adoption of enterprise systems – having been studied individually in great detail, there exists a gap, both in theory as well as in practice, of sufficient clarity on how enterprise systems
influence an organization’s ability to be agile. Literature from strategic management and information systems have provided fragmented theoretical perspectives by combining the resource-based view (Barney, 1991; Penrose, 1959), capabilities-based view (Collis, 1994; Eisenhardt & Martin, 2000; Teece et al., 1997) and knowledge-based view (Grant, 1996; Spender, 1996) of a firm with how information systems in general may influence firm agility. However, the extension of these perspectives to enterprise systems, taking into account the unique complex system characteristics of enterprise systems, reveals paradoxically opposing views on whether enterprise systems promote or hinder agility. Scholarly journals, perhaps influenced solely by known theoretical perspectives, are more inclined towards suggesting that enterprise systems may promote organizational agility (Davenport et al., 2005). On the other hand, practitioner journals have been more inclined towards suggesting that enterprise systems may hinder organizational agility (Rettig, 2007). There is also anecdotal evidence to support both sides of the argument. Thus, there exists an inherent tension between our understanding of enterprise systems and of organizational agility, with a distinct lack of clarity on how enterprise systems influence organizational agility and what the conditions are under which enterprise systems influence organizational agility (Goodhue et al., 2009). It is within this tension precisely that the locus of this dissertation resides.

In order to address the research questions of this dissertation, it takes a rigorous theory-based model building approach followed by empirical validation of the theory. The theorizing starts with the observation that mere presence or absence of enterprise systems (used synonymously with the term enterprise resource planning (ERP) systems) would be a simplistic approach to capture the complex interactions between enterprise
systems and organizational agility. Rather, we contemplate that it is the *usage* of such enterprise systems which can explain their *effects* on organizational agility. Since enterprise systems can be viewed as technology innovations, we leverage *innovation assimilation* literature which suggests that the *effects* of technology innovations can be explained by the *assimilation* of such innovations in an organization (Armstrong & Sambamurthy, 1999; Zmud & Apple, 1992). Hence we theorize that the levels of ERP assimilation - defined as “the extent to which the use of technology (ERP) diffuses across the organizational projects or work processes and becomes routinized in the activities of those projects and processes” - influence organizational agility. Since literature review did not give a clear idea of the *direction* of the influence of the levels of ERP assimilation on organizational agility, we dual-hypothesized that ERP assimilation has both a positive and negative effect on organizational agility. In addition, we leveraged *dynamic capabilities* (Sanchez & Mahoney, 1996) and *agile systems* (Cockburn, 2001) literature to extend them to enterprise systems, by theorizing that the *speed* of the dynamic capability of systems development - as exemplified by the construct of systems agility defined as “the organizational capability to successfully and swiftly change its information systems” - may influence the effects of ERP assimilation on organizational agility. The findings on these hypotheses can best be summed by the interaction plot in Figure 13.
The empirical results confirm our theoretical framework on ERP assimilation and organizational agility and show that ERP assimilation has a small but significant net positive effect on organizational agility. In addition, while having a large direct effect on organizational agility, systems agility also positively moderates the effects of ERP assimilation on organizational agility. Thus the paradox of ERP assimilation both promoting and hindering organizational agility can be theoretically explained by controlling for the effects of systems agility. At the same time, systems agility is revealed as a catalyst and key enabler for amplifying the effects of ERP assimilation on organizational agility, and thus presents itself as an object for further research and study by both scholars and practitioners.
The trajectory of the dissertation then shifts to understanding the organizational processes by which firms reconcile the agility-driven business changes with adoption and usage of enterprise systems in the firm. The qualitative research findings show that in addition to the exogenous economic and competitive forces driving changes, enterprise systems are paradoxically an endogenous agent for change to themselves. As the organizations learn about the capabilities of the enterprise system, particularly in situations where new uses for ERP data are discovered, the system itself became a recursive force for change to the system. Although one may view these changes, which are internal by source and insidious by nature, as different from the endogenous environmental changes typically considered by agility literature to be driving changes in the firm, nevertheless these endogenous ERP driven changes are an important and sometimes significant source of changes to the firm in general and enterprise systems in particular. Hence they offer a novel theoretical lens for scholars to view the dynamics in which enterprise systems and firms operate. The outcome of the sum total of these change processes to the enterprise systems and the resultant cross-boundary teaming intended to make the organization more agile often makes local activity less agile – more rigid, slow and costly. The qualitative research described a number of situations where the change processes gave rise to local rigidity and inefficiency, but ultimately fostered organizational agility. Such a paradigm was termed “go slow so you can go fast”. The effect of these change processes resulted in higher collaboration and knowledge sharing between IT and business, which in turn gave rise to higher levels of complexity and correspondingly higher levels of systemic risk.
Integrating the *theoretical* framework from Part 1 quantitative research with the *thematic* insights from Part 2 qualitative research, the final research part of the dissertation builds a theoretical model for understanding the *conditions* of organizational knowledge and *competencies* under which ERP assimilation levels influence organizational agility. Specifically, it leverages two competencies – IT competence in business (ITCB) (Bassellier et al., 2001) and business competence in IT (BCIT) (Bassellier & Benbasat, 2004) – to theorize that they have dual effects on organizational agility – mediated effects and moderated effects. The empirical results support such theorizing. ITCB is fully mediated by systems agility in its effects on organizational agility while BCIT is *partially* mediated by systems agility in its influence on organizational agility, with strong direct effects of both ITCB and BCIT on systems agility as well as strong direct effects of systems agility on organizational agility. In addition, the research uncovered that ITCB negatively moderates the effects of ERP assimilation on organizational agility. This result can best be understood visually through the interaction plot in Figure 14.
The interaction plot implies that high levels of ITCB can be a *barrier* to the positive effect of enterprise systems on organizational agility, especially at higher levels of ERP assimilation, where organizational agility *decreases* with increases in ITCB. This result is both surprising and unexpected. It can be explained by multiple alternate perspectives – *tension* between centralized IT support for enterprise systems versus decentralized structure of business units, *IT substitutes* phenomenon and *organizational hubris* (Johnson et al., 2010).

**Discussion**

As noted in Chapter 1, this dissertation is structured around the three research parts being written as three stand-alone papers suitable for publication as three separate
papers. As such, each of these three individual papers in Chapters 2-4 has a specific discussion section for the theory and results of each research part respectively. Hence the purpose of this discussion section is not to delve into a discussion of each individual element from the three research parts. On the contrary the aim is to have a broader discussion based on integrating the theory and results from the three research parts, so that all the parts combined as a mixed methods study give us a more comprehensive view than the sum of the individual qualitative and quantitative research parts. As such, it is to be noted that the discussion which will follow should be viewed less from the perspective of theoretical rigor and more as a reflection at the end of this dissertation journey.

As discussed in Chapter 1, the design of this dissertation was structured as a mixed methods study with sequential exploratory design (Creswell et al., 2003). As mixed methods literature indicates, the purpose of a sequential exploratory mixed methods study is for the qualitative research – which is done first and prior to quantitative research – to give insights into the contexts in which the phenomenon being studied occurs (Morgan, 1998). These insights then feed into the quantitative research as input for theory building and empirical validation, with results that can potentially be generalizable.

As per this sequential exploratory design, the qualitative research in Part 2 - which was completed chronologically as the first study in the three-part research – did indeed provide several insights which were leveraged for theory building and validation in the two quantitative studies that followed chronologically. However, there was one specific key insight amongst all these multiple thematic insights, that I will use as the starting point for this reflection.
That key insight was the mechanism for enterprise systems themselves to act as endogenous sources of changes. Enterprise systems provide the data and tools to analyze the business processes embedded in the enterprise systems, the outcome of which leads to optimized business processes which are then rolled out as routines in the organization. However since these new routines themselves have to be supported by the enterprise system, it results in further changes in the enterprise system to implement the updated processes which in turn leads to subsequent re-analysis, re-optimization, re-rollout and change re-implementation, ad infinitum. This insight was discussed and explained in Part 2 research using adaptive structuration theory (DeSanctis & Poole, 1994), as a recursive hermeneutical means by which technology interacts with organizations.

However, when combined with a) subsequent theory developed in Part 1 quantitative research based on enterprise systems as innovations whose effects on agility can be explained by assimilation of such innovations, as well as with b) Part 3 quantitative research that organizational competencies based on knowledge collaboration between IT and business can influence agility, the above key insight allowed me to go beyond adaptive structuration theory and reflect on a broader model of enterprise systems as innovation platforms for organizational agility. This broader model leverages innovation literature and dynamic capabilities to propose a multi-level enterprise innovation process model comprising of core system innovations and local process innovations linked together by digital processes. Such a model based on digital processes has been suggested by McAfee & Brynjolfsson (2008) in the context of information systems. I will be reframing the model from McAfee & Brynjolfsson (2008), specifically in the context of enterprise systems and with the incorporation of the results of this
dissertation. Figure 15 visually depicts the *multi-level enterprise innovation process* (MEIP) model of agility.
FIGURE 15
Multi-level Enterprise Innovation Process (MEIP) Model of Agility
Extending the view of a firm as a “bundle of resources” (Penrose, 1959), the model takes an innovation-based view of a firm as a bundle of dynamic capabilities, knowledge and innovations, in a multi-level structure. The core level (e.g. corporate unit) in this structure provides common governance and support functions, while the multiple local levels (e.g. business unit) in the structure are customer-facing units which interact with the external environment.

The core level houses the core system innovations comprising of enterprise systems and other systems. It also incorporates core dynamic capabilities which are needed for making changes to the core processes and to core system innovations e.g. systems agility along its dimensions of speed of change and success of change as well as core organizational agility. Finally, it holds core organizational knowledge and competencies e.g. IT competence in business and business competence in IT, along with other core level knowledge.

The local level houses local processes which are customer facing and which are utilized in the routine servicing of the customer, as well as for interacting with the environment. At the same time, the local level houses local dynamic capabilities needed for making changes to local processes e.g. local organizational agility with sensing components to sense both the needs of the customer as well as the environment and a responding component to respond appropriately to the needs of the customer and the environment. In addition, the local level comprises of local organizational knowledge primarily consisting of business competencies viz. business competence in business (BCIB) which represents the level of business knowledge for operating at the local level as well as some level of IT competence in business (ITCB), which represents the level of
IT knowledge in business for operating and utilizing the system-enabled local processes. When the local processes are changed by the local dynamic capability of local agility in response to either the customers or the environment in tandem with the local business knowledge (BCIB), it results in the generation of local process innovations. Since the local level is customer facing, it can serve as an incubator for quickly testing the efficacy of the local process innovations with high agility. If the local process innovations fail, they can quickly either be terminated or incrementally adjusted depending on the results, with some support and resources from core level, but with no impact on the other local levels.

If the local process innovations succeed, then the updated local processes are sent back to corporate as digital processes - defined as processes and routines which are technology-enabled by enterprise systems and hence are embedded in the enterprise system – which need to be changed in the enterprise system, so that they can be quickly replicated to other business units to maximize organizational agility. The higher the level of ERP assimilation in the organization, the higher would be the unit scope diffusion (i.e. number of local units in which ERP has been implemented) implying that the number of local levels where the updated digital processes could be replicated quickly would be larger, resulting in higher enterprise-level organizational agility. Similarly, the higher the level of ERP assimilation in the organization, the higher would be the functional scope diffusion (i.e. number of functional modules of ERP that have been implemented). Thus, if the updated digital processes are determined to need updates to ancillary digital processes in other functional modules of the enterprise system for more organizational effectiveness, that would be possible, again leading to higher enterprise-level
organizational agility. Finally, the higher the level of ERP assimilation in the organization, the higher would be the *routinization* of enterprise systems in the organizational processes, hence the higher would be the probability that the updated digital processes when replicated to other local levels would ‘*stick*’ in the local processes of the new local units, resulting in higher agility. Thus, the combined effect of higher unit scope diffusion, higher functional scope diffusion and higher routinization of enterprise systems in support of replication of updated digital processes and hence rapid *permeation* of local process innovations, with corresponding higher agility, can explain one of the key results in Part 1 research of ERP assimilation positively influencing overall organizational agility.

At the same time, higher levels of the core dynamic capability of systems agility will *increase* the stability of the local processes in the interval between successive changes by *decreasing* the time required for the system changes. This would result in higher routinization and an *increase* in the probability that the updated digital processes when replicated to local levels would ‘*stick*’ in the local, hence driving higher enterprise organizational agility. This can help explain the other key result from Part 1 research, of systems agility being a catalyst for *amplifying* the effects of ERP assimilation levels on organizational agility.

In summary, updated and optimized digital processes - encapsulating local *process innovations* and enabled by the *core system innovations* like enterprise systems - can be quickly *replicated* as new innovations in new local levels, leading to *rapid sensing* in one location driving *rapid responding* in other locations with a *force-multiplier effect*,
giving rise to higher organizational agility and increased competitive advantage for the entire enterprise, when operating in dynamic and turbulent markets.

Changes to digital processes embedded in enterprise systems require high levels of competencies in both IT and business, in their own knowledge domains respectively. In addition, to coordinate their actions and respective domain specific knowledge around digital process changes, they require some level of managerial governance. Since digital processes are executed at the local business unit level but embedded in the core systems at corporate level, such governance can be complex, due to coordination needed not only within corporate between IT and business but also potentially across corporate and business unit levels. The overall effect of this governance would be higher speed and higher success of changes resulting in higher overall systems agility, when compared to the absence of such governance. At the same time, complexity of such governance may lead to higher governance costs – based on the distributed nature of digital processes – which in turn can lead to local slowdown and local rigidity, as well as higher levels of risk. This is confirmed via the qualitative study observation of the paradigm of “go slow so you can go fast”, as well as the observed higher levels of complexity and risk.

Higher levels of cross-knowledge in both IT and business of each other’s knowledge domains can lead to lower governance costs, since the amount of coordination needed for making changes to distributed digital processes would be lower driven by higher efficiency of decision making as well as enhanced trust between business and IT based on the higher levels of cross-knowledge. Such lower governance costs can lead to an increase in the speed as well as success of the changes to digital processes. This is confirmed empirically by the results of Part 3 research that higher
levels of both IT competence in business and business competence in IT – representing levels of cross-knowledge – strongly and positively influence the core dynamic capability of systems agility. Combined with the result from Part 1 research of systems agility having a strong direct influence on organizational agility, it can explain the Part 3 research of systems agility mediating the influence of ITCB and BCIT on enterprise-level organizational agility.

Although higher levels of ITCB and BCIT at core level will lower governance costs, it will not completely eliminate them, since some level of governance costs are necessary for efficient coordination at core level between IT and business, resulting in faster replication of digital processes to other local units and higher overall enterprise agility. However, it is possible that for some high-velocity environmental situations, even this minimum level of governance costs and associated delay may not be acceptable, for the local unit to respond quickly. In such situations, if the local unit additionally has high levels of local IT competence in business (Note: in the multi-level model, ITCB levels are not uniquely present at the core level, but are also present at the local level) and core level IT support needed for quick changes to digital processes during the trial incubator phase is not forthcoming, local level may be tempted to short circuit the process of digital processes flowing back to core level for updates. Rather, local level may leverage their high levels of ITCB (albeit lower when compared against IT competence in IT at core level) to develop workarounds and themselves act as IT substitutes. Such behaviors may also be caused by organizational hubris at the local business level, driven by otherwise high levels of local autonomy. Either way, such workarounds would cause a departure from the use of standardized digital processes enforced by enterprise systems at the local
level. Over a period of time, with the standard digital processes continuing to be updated in the enterprise systems based on updated digital processes from other levels, the divergence between local processes at this local level and other local levels would simply keep on increasing, leading to lower ERP routinization as well as lower ERP functional scope diffusion and correspondingly lower levels of overall enterprise organizational agility. This is again confirmed by the results in Part 3 research that higher level of ITCB lowers the effects of ERP assimilation (through lower diffusion and routinization) on organizational agility i.e. ITCB negatively moderates the influence of ERP assimilation on organizational agility.

Overall, the multi-level enterprise innovation process (MEIP) model comprising of core system innovations and local process innovations linked together by digital processes appears to have good explanatory powers for all of the key findings of this dissertation. Although this model is the outcome of reflection rather than rigorous theory building, it has the potential for an interesting implication for practice, which is covered in the next section.

**Implications of Multi-Level Enterprise Innovation Process (MEIP) Model for Practice**

One of the primary implications of the MEIP model for practitioners is on the perennial debate between the centralized role of IT in support of high efficiency versus a federated or distributed structure of IT in support of local innovation and agility, and the resulting management of tension between these seemingly contradictory objectives. This tension of maintaining centralized control and direction while permitting local and flexible business driven innovation has remained highly contentious. The MEIP model
may potentially provide insights for resolving this tension (McAfee & Brynjolfsson, 2008).

Even though products in traditional companies are not becoming digital, processes in almost all firms are becoming digital i.e. they are becoming technology enabled processes. Similar to digital photos which can be copied and replicated easily with low costs, digital processes too can be copied, replicated and rolled out across geographically spread out units of the firm with lower costs. The enabling technology for the replication of these digital processes is enterprise systems. In developing a future IT strategy for enabling agility and innovation, practitioners can incorporate the deployment of a core system innovation like an enterprise system to serve as a carrier for digital processes. These digital processes can then be used at the local level, where they can potentially be innovated based on local knowledge. Local innovations that are a source of competitive advantage can then be copied back and propagated with lower costs via digital processes to all other parts of the firm. This can result in the firm rapidly gaining a competitive advantage in the market.

Thus, practitioners and management executives can address the tension between central control versus local flexibility, by viewing it through the lens of a multi-level enterprise innovation view in which enterprise systems function as core system innovations which enable the rapid replication of local process innovations, resulting in increased overall organizational agility.
Limitations

This dissertation has several limitations, which can be categorized into three categories of a) data collection, b) research bias and c) research design.

Data collection

The data collected in this dissertation was limited to organizations in a specific geographical boundary viz. that of a specific country USA. Hence the findings may not be generalizable outside USA. The organizations selected for data collection have all implemented one specific ERP solution viz. SAP. Hence the findings may not be generalizable to organizations with other ERP solutions which would need further study. In addition, newer versions of ERP systems offering Web services or cloud-based services may change the configurability of ERP systems such that assimilation effects may accrue earlier.

The qualitative data sample comprised of only three firms in three industries (retail, transportation and consumer products). Hence the findings may not be generalizable to other industries or to other firms in the same industries. In addition, only eight business and technical professionals in each firm were interviewed. Including more professionals from a broader range of organizational functions could have improved the findings.

Research Bias

To participate in quantitative data collection, organizations were randomly selected by a non-profit trade group in USA comprising of members who have implemented SAP. It is not known if the request from an association explicitly introduces
any selection bias while identifying the organizations to participate in the survey. Since the link to the web-survey was emailed by a third-party non-profit association to the organizations directly, it is not possible to empirically measure or validate the presence of non-response bias or conduct wave tests to compare late or early respondents (Armstrong & Overton, 1977).

Although a conscious effort was made to reduce researcher bias, this researcher’s extensive professional and management experience in the field of ERP implementations and sustainment may have affected his analysis or interpretation of the data.

**Research Design**

This dissertation study used a cross-sectional research design in the quantitative research parts i.e. the information about the constructs being researched was designed to be captured at only a point of time. Such a snap-shot approach may have limitations in terms of studying the time effects between research variables. Specifically, modern enterprise systems are relatively new innovations that have been adopted in organizations in the last two decades. When applying the concept of innovation assimilation (Purvis et al., 2001) to enterprise systems through the construct of ERP assimilation (Liang et al., 2007), it is possible that assimilation of novel and complex innovations like enterprise systems may take a long period of time and may happen in stages over time. The cross-sectional research design in this dissertation limits the capture and analysis of such stages of assimilation over time and their effects. Similarly, the constructs leveraged in this dissertation of systems agility (Davis, 2009) and organizational agility (Tallon & Pinsonneault, 2011) are essentially dynamic capabilities, whose *levels* influence or are
influenced by other constructs. Hence, the cross-sectional research design in this dissertation limits the ability to capture the changes in such levels over time, and the resultant effects on other constructs of interest.

**Contributions to Theory**

Despite the above limitations, this dissertation offers several theoretical contributions. They are covered below.

**Assimilation-based Theoretical Framework**

In addition to currently known resource-based (Barney, 1991; Penrose, 1959), capabilities-based (Collis, 1994; Eisenhardt & Martin, 2000; Teece et al., 1997) and knowledge-based (Grant, 1996; Spender, 1996) theoretical frameworks for understanding the influence of enterprise systems on organizational agility, this dissertation adds a new assimilation-based theoretical framework for viewing the effects of enterprise systems on organizational agility. Specifically, the results support the theoretical positioning that assimilation of enterprise systems based on the dimensions of diffusion and routinization is a fruitful framework to understand the impact of enterprise systems on organizational agility. This also implies that the theoretical approach based on usage of enterprise systems to explain their assimilation-based effects on organizational agility is valid.

**Extension to Dynamic Capabilities**

The findings in this dissertation research show that the dynamic capability of systems agility has a direct and significant effect on organizational agility. Hence it not only supports the dynamic capabilities view that market turbulence requires changes in business processes and product strategies which necessitates system development
capabilities (Eisenhardt & Martin, 2000), but in addition it supports the *theoretical extension* to dynamic capabilities by validating the theorizing that the *speed* of such system development capabilities - as exemplified by the dynamic capability of *systems agility* - positively influences organizational agility.

**Underlying Mechanism for Organizational Competencies**

The effects of two key organizational competencies – IT competence in business (ITCB) and business competence in IT (BCIT) – on organizational agility have not been previously researched. This dissertation adds to the body of theoretical research on organizational agility by not only showing the strong influence of both ITCB and BCIT on organizational agility, but it also reveals the *underlying theoretical mechanism* for the effects of ITCB and BCIT on organizational agility, by showing that systems agility *mediates* the effects of both ITCB and BCIT on organizational agility.

**Theoretical boundary of ITCB Effects on Organizational Agility**

Our theorizing logic that IT competence in business influences the *routinization* of enterprise systems in the work processes of business and correspondingly the impact of ERP assimilation on organizational agility, through *better* knowledge in business of the capabilities and usage of ERP technology, is validated by this dissertation. In addition, the dissertation also unfolds the *theoretical boundary* of such effects by showing that *excessive* IT knowledge in business beyond a threshold is potentially a *barrier* to the positive influence of enterprise systems on organizational agility, in organizations with high ERP assimilation.
Construct Operationalization and New Measurement Development

In collaboration with Goodhue (see Goodhue et al., 2009), this dissertation has extended the construct measurement scales for ERP assimilation from Liang et al. (2007) in conjunction with definition of assimilation from Purvis et al. (2001), to develop a new psychometrically valid measurement scale which incorporates the dimensions of diffusion, diversity of routinization and depth of routinization in the operationalization of the construct. Since one of the key theoretical contributions of this research is an assimilation-based theoretical model for understanding the effects of enterprise systems on organizational agility, this new measurement scale can be used by future researchers and practitioners in order to assess the levels of ERP assimilation in organizations which have implemented enterprise systems.

Contributions to Practice

This dissertation suggests several implications for practice, addressed to primarily two key audiences – business executives/leaders and enterprise system designers.

Business Executives/Leaders

The high costs of implementing and maintaining enterprise system (typically in the millions of dollars) coupled with the high failure rates in both implementation as well as post-implementation phases, have justifiably made business executives and leaders take a closer look at enterprise systems implemented in their organizations (Vaman, 2008; Wailgum, 2008). In addition, with the increased focus (and in some cases directives) at the C-level on ensuring that organizations can not only survive but succeed in the Schumpeterian dynamics of hyper-competition and market turbulence, business
executives and leaders have questioned whether such enterprise systems can help organizations in their quest to be nimble and agile. This is evidenced by views, especially in practitioner literature, that not only do enterprise systems not help in promoting organizational agility, on the contrary claims have been made that their complexity introduces rigidity resulting in enterprise systems hindering organizational agility (Rettig, 2007). To the best of our knowledge, this dissertation is the first study which directly addresses the influence of enterprise systems on organizational agility using a rigorous theory-based approach and empirical validation. The research, taking a usage and assimilation based approach, shows that not only do enterprise systems not introduce rigidity in the organization, on the contrary they have a net positive and direct effect on organizational agility. Research has already shown that enterprise systems improve efficiency and increase productivity in organizations. This dissertation adds to that research, by showing that enterprise systems also increase organizational agility. Business leaders need not make Faustian choices between efficiency and agility. This research suggests to business executives and leaders that organizations can achieve dexterity in both efficiency and agility, through adoption and usage of enterprise systems.

In addition, C-level management needs to take an active leadership role in assimilation of enterprise systems implemented in their organization. Such assimilation can be increased by two primary means – diffusion and routinization. Diffusion of enterprise systems in organizational projects or work processes can be increased through increased rollout of existing functional modules of the ERP systems to new business units in the organization (unit scope diffusion), as well as by increasing roll out of additional integrated functional modules in current business units (functional scope diffusion). On
the other hand, *routinization* of enterprise systems in organizational projects and processes can be increased through increased *usage, knowledge* and *training*. In a sense, leaders need to ensure that enterprise systems are *embedded within the DNA of the organization*, since research in this dissertation clearly shows that the higher the *assimilation* of enterprise systems in an organization, the higher is the ability of the organization to be *agile* in the face of dynamic competitive pressures.

With a focus on efficient operations in response to globalized competition, management may tend to focus on cost containment strategies, also known as ‘*keep the lights on*’, in their approach to information systems maintenance. However, the findings in this dissertation indicate that IT executives may need to *focus* and *spend* (when necessary) on inculcating new systems development dynamic capabilities in the organization, since the *speed* of such systems development capabilities (called *systems agility* in this dissertation) not only has a direct effect on making the organization agile, but in addition it has an *amplifying* effect in enabling the positive effects of enterprise systems on organizational agility. In fact, this dissertation suggests that IT executives need to view systems agility as a critical *catalyst*, necessarily required to unlock the value of their enterprise systems in making their organizations agile.

Having realized the key role of *systems agility* in enabling enterprise systems to act as platforms for organizational agility, business executives and leadership can justifiably ask the subsequent question on what *managerially actionable* steps they can take to increase systems agility. The research in this dissertation reveals the role of organizational *knowledge* and *competencies* in their influence on systems agility *as well as* on organizational agility. Specifically, this dissertation identifies two such key
organizational competencies – IT competence in business (ITCB) and business competence in IT (BCIT). The research shows that both ITCB and BCIT have a strong direct effect on systems agility. In addition, it also shows that systems agility mediates the effects of both ITCB and BCIT on organizational agility. In layman’s terms, this means that systems agility is required to be present as a necessary pre-requisite in the organization, for capturing all the effects of both ITCB and BCIT in making the organization agile. This further adds to the prior discussion on the criticality of executives in understanding the catalyst role of systems agility for organizational agility, as well as in taking a leadership role in increasing systems agility in the organization.

Several tactical means were identified in the qualitative research part of this dissertation, which may increase ITCB and BCIT. One was development of centralized customer-facing and data governance teams, comprised of both business and IT team members. Such integrated teams were similar in concept to those created temporarily as part of a project team during implementation phase, however differed during sustainment in terms of the permanency of the structure as well as the depth of cross-disciplinary integration. Another was rotation of leaders between business leadership roles and IT leadership roles, so as to have effective transfer of IT competencies and business competencies across business and IT respectively.

Although high levels of IT competence in business are desirable for higher systems agility and correspondingly higher organizational agility, leaders need to be cautious that excessive IT knowledge in business is potentially a barrier to enabling the influence of enterprise systems on organizational agility. Thus, business and IT executives need to recognize the debilitating effects of too much ITCB and must seek to
achieve an appropriate \textit{balance}, such that it increases systems agility, but not to such an extent that an \textit{IT substitutes} effect occurs to the \textit{detriment} of overall organizational agility.

Systems agility has been shown to be a key enabler of organizational agility. It also has a \textit{central} role in the multi-level enterprise innovation process model in \textit{speeding} the replication and propagation of digital processes. Over the last decade, there has been a strong movement towards outsourcing of IT services, driven primarily by lower costs, global support and global talent availability. The results of this dissertation as well as the multi-level enterprise innovation process model strongly suggest that systems agility needs to be \textit{added} to the existing framework of criteria, when evaluating the IT services outsourcing models being considered for the firm. More specifically, business leaders need to carefully evaluate the impact of these IT services outsourcing models on the dynamic capability of systems agility, \textit{vis-à-vis} the needs of the organization to be agile in alignment with the nature of agility environment – moderate or high-velocity – that the firm operates in.

\textbf{Enterprise System Designers}

Finally, this dissertation suggests to designers of enterprise systems of the need for a \textit{paradigm shift} for the design and architecture of enterprise systems. Such a shift could be anchored around the concept of \textit{digital processes} and the role of enterprise systems as core system innovations in a multi-level enterprise innovation model, where local process innovations can be rapidly prototyped with minimal resources from corporate support and then if the local process innovation succeeds, then the underlying
design and technology of the enterprise systems can package the local process innovations as a bundle of digital processes which can then be easily and rapidly replicated by the enterprise systems to all other relevant local levels and customer-facing business units, thus increasing overall organizational agility.

In addition, another facet of this shifted paradigm could be to have the enterprise systems designed with an architecture built around the central tenet of systems agility. The underlying design and technology would need to be thought out from the ground up to support systems agility at every level of the architecture, based on the revelation of systems agility in this dissertation as a critical catalyst for enterprise systems to serve as enduring platforms for organizational agility.

An interesting implication of this paradigm shift would be on the current evolution of enterprise systems towards cloud ERP, where it is envisaged that substantially all ERP functions would be made available to organizations through a cloud-based provider of ERP services, with no onsite implementation, and licensing being billed by usage. If the design of such cloud ERP services enables systems agility, then they are well-positioned to help organizations in their goals to be agile. On the other hand, if the designers of such cloud ERP services are not able to leverage the research findings of this dissertation on the role of systems agility, not only to directly influence organizational agility but also as a necessary pre-requisite for the effects of organizational competencies like ITCB and BCIT on agility, then it is possible that such cloud ERP services may not succeed, as organizations inexorably shift towards the goal of higher organizational agility and inevitably align their people, processes and technology with such a goal.
Future Research

This dissertation suggests multiple directions for further research. First, research in this paper can be replicated in countries outside of USA as well as in organizations with enterprise systems other than SAP, in order to make the results more generalizable. Second, the research seems to suggest that the level of architecture integration of technology innovations may influence organizational agility. Hence one way to further pursue this direction would be to analyze the effects of the configurations of functional modules within the enterprise systems on organizational agility. Third, analyzing the effects of innovation assimilation on the constituent components within organizational agility (e.g. entrepreneurial agility, adaptive agility, etc), will provide a rich insight into the mechanisms of innovation assimilation. Fourth, the effect of levels of environmental turbulence on the assimilation-based model of enterprise systems proposed in this dissertation can provide insights on changes to construct effects in the model. Fifth, this research opens up further research areas on identifying and analyzing the mitigating factors for reducing the impact of IT services outsourcing on systems agility and hence organizational agility. Finally, the multi-level enterprise innovation process model proposed in this dissertation can serve as input to scholars in innovation management, for building a comprehensive theory of innovation which incorporates existing innovation theories with the presence of core system innovations at corporate level and local process innovations at the business unit level, both of which are connected by digital processes, all of which are enabled through the platform of enterprise systems.
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