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A Review of ERP Research: A Future Agenda for Accounting Information Systems

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ABSTRACT: ERP systems are typically the largest, most complex, and most demanding information systems implemented by firms, representing a major departure from the individual and departmental information systems prevalent in the past. Firms and individuals are extensively impacted, and many problematic issues remain to be researched. ERP and related integrated technologies are a transformative force on the accounting profession. As the nature of business evolves, accounting expertise is being called on to make broader contributions such as reporting on nonfinancial measures, auditing information systems, implementing management controls within information systems, and providing management consulting services. This review of ERP research is drawn from an extensive examination of the breadth of ERP-related literature without constraints as to a narrow timeframe or limited journal list, although particular attention is directed to the leading journals in information systems and accounting information systems. Early research consisted of descriptive studies of firms implementing ERP systems. Then researchers started to address other research questions about the factors that lead to successful implementations: the need for change management and expanded forms of user education, whether the financial benefit outweighed the cost, and whether the issues are different depending on organizational type and cultural factors. This research encouraged the development of several major ERP research areas: (1) critical success factors, (2) the organizational impact, and (3) the economic impact of ERP systems. We use this taxonomy to establish (1) what we know, (2) what we need, and (3) where we are going in ERP research. The objective of this review is

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to synthesize the extant ERP research reported without regard to publication domain and make this readily available to accounting researchers. We organize key ERP research by topics of interest in accounting, and map ERP topics onto existing accounting information systems research areas. An emphasis is placed on topics important to accounting, including (but not limited to) the risk management and auditing of ERP systems, regulatory issues, the internal and external economic impacts of ERP systems, extensions needed in ERP systems for XBRL, for interorganizational support, and for the design of management control systems.

Keywords: enterprise resource planning; accounting information systems; technology literature review; critical success factors (CSF); ERP economic impact; ERP extensions; management control; regulation.

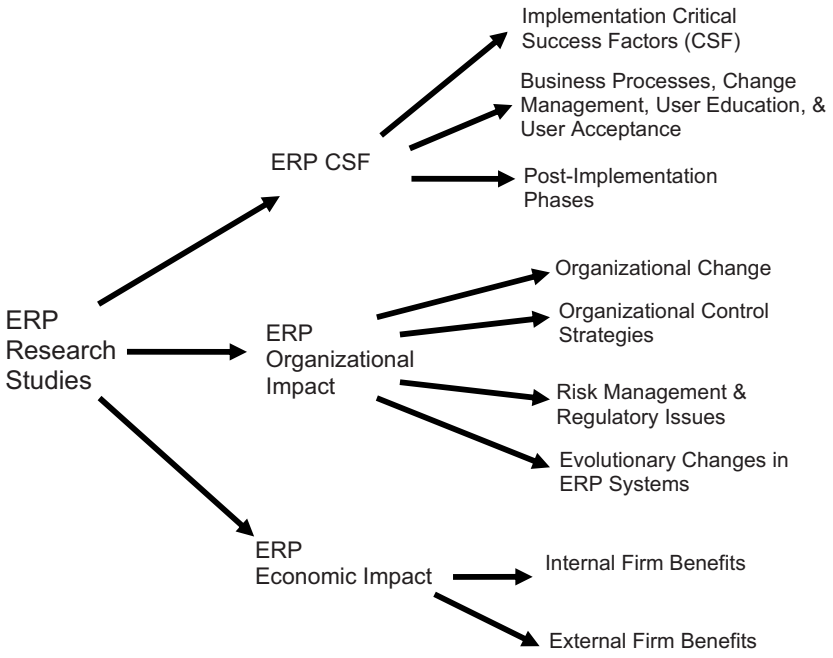
I. INTRODUCTION

In the 1990s, Enterprise Resource Planning (ERP) systems were widely implemented in multinational corporations to integrate diverse and complex corporate operations. Early accounting systems formed the nucleus for contemporary ERP systems (Deshmukh 2006). ERP system adoption is motivated by management's need for timely access to consistent information across the diverse functional areas of a company. Typical motivations for ERP adoption include regulatory compliance, upgrading legacy systems, business process reengineering, integration of operations, and management decision support (Robey et al. 2002). ERP systems are integrated cross-functional systems containing selectable software modules that address a wide range of operational activities in the firm, such as accounting and finance, human resources, manufacturing, sales, and distribution (Robey et al. 2002). ERP systems have also been defined as commercially available, modularly packaged business software that enables an enterprise to efficiently and effectively manage its resources (products and services, personnel, capital assets, etc.) by virtue of being a complete and integrated application to support an organization's information processing needs (Nah et al. 2001).

From the perspective of the firm, ERP systems are usually the largest and most demanding information systems implemented. Typically, an ERP system implementation is the largest single IT investment, impacts the greatest number of individuals, and is the broadest in scope and complexity (Chang et al. 2008). From the perspective of the individual user of an ERP system, ERP demands a broader set of information systems (IS) and business knowledge (Sein et al. 1999), changes job role definitions, increases task interdependencies (Kang and Santhanam 2003), restricts flexibility in job tasks (Park and Kusiak 2005), and has been shown to lower job satisfaction (Butler and Gray 2006).

Much of the early ERP research consisted of relatively simple, descriptive studies of firms implementing ERP systems. Based upon these studies, researchers started to address other research questions, such as: What does it take to successfully implement an ERP system? Are ERP systems worth the time and effort? Is ERP systems implementation and use the same in all cultures/businesses/organization types? How do ERP systems influence individuals and the organization itself? How well does ERP address corporate compliance and risk management issues? These research questions helped foster the development of the major ERP research areas: (1) ERP systems Critical Success Factors (CSF) (which examines a variety of topics, ranging from system implementation, user acceptance, and adaptation to domain-specific ERP factors related to country, culture, and industry), (2) ERP organizational impact research (which includes research focused on business processes, management control, security, regulatory, and organization change issues), and (3) the economic impact of ERP systems (both external and internal). From each of these major areas a more refined set of research topics arose (see Figure 1).

FIGURE 1
ERP Research



The ERP systems CSF literature quickly matured and started to examine specific CSFs in more detail, including the impact of business process reengineering (BPR), education, change management, and user acceptance. This research also includes examining whether there is a difference in ERP implementation and use in different sized firms, countries, cultures, and industries. Over time, since organizations are expected to provide a self-evaluation of the relative success of the ERP implementation compared to planned outcomes, the post-implementation phase research area was developed from the CSF literature.

Based upon the ERP organizational impact studies, other research areas have emerged that have been examined using a variety of research techniques, including grounded research techniques, longitudinal studies, and cross-sectional research. Questions have addressed how organizations adapt to their environment, regulatory compliance, security, and audit of ERP environments, managerial use of ERP system reports (including the use of decision support systems, business intelligence systems, analytics, and management control systems). Regulatory and policy research has resulted from external pressures and mandates upon organizations, including the emerging impact of recent XBRL reporting requirements. Organizational benefits are often championed, yet there is minimal research that empirically documents these advantages.

The ultimate objective of any organizational initiative is to demonstrate some type of economic advantage, whether it is associated with cost savings, improved efficiencies, or better decision-making. The ERP implementation literature has many such studies. From the economic impact area, two research streams initially emerged: one examines the firm benefits based upon the

results reported in the organization's financial statements, and the other by external ratification of management decisions through the use of stock prices. An emerging area, the evaluation of inter-organizational economic benefits, has received scant attention.

This review is structured around the major research areas presented in Figure 1: ERP CSF research, ERP organizational impact studies, and ERP economic impact research. All areas are examined in enough detail so that exemplar studies are identified, relatively mature sub-areas are specified, and areas needing additional research are proposed. Key ERP accounting information systems (AIS) research is organized by topics of interest in accounting and ERP topics mapped onto existing AIS research streams. Emphasis is placed on important topics in AIS and in areas representing the greatest impact on the accounting profession and accounting methods. Some critical areas deserving extended focus include risk management, security, and the auditing of ERP systems, the extensions needed in ERP systems for XBRL and inter-organizational support, and the design of management control systems (i.e., the managerial accounting expertise). Dependence on ERP and related information systems underlies the need for management controls to either be embedded within or linked to ERP systems so that a single set of performance numbers are used for planning and controlling the enterprise.

Particular attention is paid to leading journals in accounting information systems and information systems, along with supplemental articles from other journals which provide insight into the interesting research opportunities for AIS researchers. The focus here is on seeking ERP-related articles that expand the boundaries of current AIS research in the topic by offering new insights, alternative viewpoints, and interesting research questions for future AIS research. This leads to the inclusion of selected conference proceedings and journals from other disciplines such as management, industrial production, and operations research. Rather than review ERP literature within the narrow timeframe of a few specific years, as in some prior ERP reviews (Esteves and Pastor 2001; Botta-Genoulaz et al. 2005; Esteves and Bohorquez 2007; Moon 2007), this review focuses on major accounting-related themes across ERP topics without limitation to a specific timeframe or narrow journal list. The intent is to provide broad insights into the development of streams of ERP research with the goal of identifying important AIS research themes and questions for future investigation. The Appendix located in the additional online resources of this paper includes the key journals containing the majority of ERP references in this review, as well as additional journals which expand and illuminate discussion of ERP accounting information systems trends and research questions.

This review is timely because ERP and related technologies are a transformative force on the accounting profession. As companies rely on integrated technology innovations such as ERP to increase competitiveness and comply with regulations, the accounting profession is undergoing significant related change. Accounting activities are becoming more tightly intertwined with other functional areas of the firm, and ever more dependent on information systems which, more and more often, are integrated commercial ERP systems. Accounting expertise is being called on to make broader contributions to the company, such as reporting on nonfinancial measures, auditing information systems, implementing management controls within information systems, and providing management consulting services. Meanwhile, ERP systems are changing the nature of business by collecting greater amounts and types of internal performance data, enforcing business processes, restricting and monitoring employee job tasks, and supporting internal controls and audit trails to a greater extent than ever before. The goal of this review is to provide an up-to-date introduction to the ERP research literature and to provide a framework for organizing AIS ERP-related knowledge so as to engender interest in areas that AIS researchers can provide unique insights and contributions to the literature. It provides a significantly different perspective than prior reviews (Esteves and Pastor 2001; Botta-Genoulaz et al. 2005; Esteves and Bohorquez 2007; Moon 2007), which examined ERP research from a generalist information systems perspective.

The next section reviews the ERP CSF research, followed by a review of the organizational impact studies. This is followed by an analysis of the economic impact studies. The research findings are synthesized and issues of primary concern to accounting researchers are identified. This review then presents suggestions for future research based upon the ways that accounting information systems expertise can bring unique perspectives to ERP research and lead in investigating ERP-related innovations being embraced by organizations.

II. ERP CRITICAL SUCCESS FACTORS

In this section, we review the literature that strives to identify the factors necessary for a successful ERP system implementation (or reimplementation) and effective ongoing usage. The ERP critical success factors (CSF) topic has been the most prolific area in early ERP research. This research has identified many contributing factors, but has not fully succeeded in specifying the necessary and sufficient factors. Several critical factors for a successful ERP implementation have received significantly greater attention in the literature (those of business process reengineering, change management, user education, and acceptance of the new enterprise system), and these are reviewed in more detail in this section. Finally, this section concludes with a review of the research surrounding post-implementation issues.

Critical Success Factors Research

A significant amount of ERP research has focused on identifying the factors critical for success in implementing ERP systems. ERP systems are very expensive, complex, impact the entire organization, and if they fail, they have the potential of contributing to the failure of the organization itself (Scott 1999). Critical success factors (CSF) have been defined as those few things that must go well to ensure success for a manager or an organization (Boynton and Zmud 1984). CSF were developed to help identify critical areas of concern and provide measures that would aid in the management of those areas (Boynton and Zmud 1984). The critical success factors research in the implementation of ERP systems has typically focused on the identification, through either case study or surveys, of the factors associated with successful implementations. It typically does not address the issue of appropriate metrics. An exemplar set of papers investigating critical success factors is presented in Table 1 of the additional online resources of this paper.

Many studies consistently identified a set of core factors that are critical to the success of ERP implementations, such as top management support, the implementation team, organization-wide commitment to the system, and fit between the ERP systems and the organization (Ross and Vitale 2000; Scott and Vessey 2000; Stephanou 2000; Murray and Coffin 2001; Somers and Nelson 2001; Hong and Kim 2002; Somers and Nelson 2003; Finney and Corbett 2007). Researchers have observed that the critical success factors appeared to be highly correlated and changes in any one of them would influence the others (Akkermans and van Helden 2002). Several researchers have focused on technology lifecycle stage models that categorized firms that implemented ERP systems along a continuum (James and Wolf 2000; Holland and Light 2001; Peterson et al. 2001). O'Leary (2000) examined the role of ERP systems in a number of e-business initiatives and found ERP systems provided the infrastructure and technology that allowed major changes in processes that supported e-business.

Based on prior research (Grabski et al. 2001; Somers and Nelson 2001; Akkermans and van Helden 2002), Grabski and Leech (2007) developed a list of control procedures utilized by organizations for an ERP implementation, finding support for a theory of control complementarity as applied to ERP (and other complex systems) implementation projects. A single type of control was not used; rather, multiple controls were used and were used for multiple purposes. They identified

five overarching control factors for a successful ERP implementation: project management, change management, alignment of the business with the new information system, internal audit activities, and consulting and planning activities.

Other researchers have used different approaches to identify factors related to ERP implementation success. Bradley (2008) examined success factors based upon classical management theory, Bradford and Florin (2003) based their study upon the theory of diffusion of information, and Wang et al. (2007) explored organizational process fit of the ERP system. Firm size is also an important factor that many papers have found significant. Early research into potential differences between ERP implementations in large firms versus small and midsized enterprises (SMEs) examined the ERP selection and implementation process (Bernroider and Koch 2001). SME structural issues were a determining factor in ERP selection and implementation timing (Buonanno et al. 2005). SMEs chose different ERP software, shorter implementation times, and expected greater ERP adaptability and flexibility than large firms. SMEs have a greater need for top management support (Muscatello et al. 2003), process discipline, and high-capability project management consultants (Snider et al. 2009), while strategic advantages and linkages to global activities are significantly more important to large firms (Mabert et al. 2003). Further, large firms were more interested in managing process integration and data redundancy through ERP implementation than SMEs. As the SME ERP market expands, investigation into SME CSF research is growing in importance.

Some research has examined ERP implementation and use in specific companies, e.g., Rolls-Royce (Yusuf et al. 2004), and in specific functional areas, e.g., inventory control (Mandal and Gunasekaran 2002), or in specific industries, e.g., healthcare (Stefanou and Revanoglou 2006) and publishing (Baray et al. 2008). In addition to typical CSF, there are often specific nuances unique to the industry or functional areas that result in the need for customization. The ability to recognize the needed modifications requires deep knowledge of both the specific subcategory (i.e., industry, functional area, or business) and ERP systems. ERP system implementations have also been examined in various regions of the world (Ramirez and Garcia 2005; Rasmy et al. 2005) and from a variety of perspectives. In summary, researchers should also take into consideration country, cultural, and industry-specific factors. Some exemplar papers are summarized in Table 2 of the online resources.

While it is not a typical CSF study, Lin et al. (2006) build upon the DeLone and McLean (1992, 2003) information systems success model, and relate the individual impact to balanced scorecard measures (i.e., financial effectiveness, customer effectiveness, internal business effectiveness, and innovation and learning effectiveness). They demonstrate that the integration of the information systems success model and the balanced scorecard constructs jointly predict ERP system success. They suggest that the use of the balanced scorecard will allow organizations the ability to more easily assess the positive (negative) effects of the ERP system and enhance the ability to manage the ERP system implementation.

Overall, CSF findings from the reviewed research indicate that implementing an ERP system is not like a typical, functionally oriented IT system. ERP implementations are linked with the firm's operational structure and business processes, which calls for joint activities in operations and process reengineering as well as ERP configuration. It is a complex and challenging task, and many factors jointly impact the level of success obtained by the organization. To address long-term use of ERP in place of a static ERP CSF model, King and Burgess (2006) propose a dynamic model of ERP success. Firms with mature ERP systems face system upgrades, new module deployments, vendor changes, and various other types of ERP reimplementations as their goals and technology needs change. Finney and Corbett (2007) lament the fact that research has not considered ERP CSF from the perspectives of key stakeholders. Since most of the CSF research

focuses on the view from top management (or consultants), the individual user insights are often missing. With the maturing and long-term use of ERP, more investigations of the later phases of the lifecycle are needed.

Much has been learnt regarding what factors are, in general, critical for a successful ERP system. However, many questions remain unanswered. The most vexing issue is a determination of the process to be followed in applying CSF. We know that CSF interact (Grabski and Leech 2007). However, we do not know how multiple CSFs interact; whether they would interact in the same fashion in different contexts or different lifecycle stages, or if there is a consistent underlying factor or set of factors or complex hidden environmental contingencies. Similarly, we do not know if different CSFs apply in different situations. For example, do CSFs in a first-time implementation differ from the CSFs for firms with mature ERP systems undertaking new module deployments or vendor changes? Does a change in the ERP technology base (e.g., cloud-based applications versus traditional in-house hosted ERP environments) result in new or different CSF? One line of thought is that ERP systems are primarily people systems that are enabled through technology (Wallace and Kremzar 2001); as such, there should not be a change in the CSF. Another view is that a change in the technology modifies the way in which people interact with the system (Boudreau and Robey 2005; Dery et al. 2006a, 2006b; Grant et al. 2006) and, consequently, there should be a different set of issues and CSF. These are researchable questions.

Some may argue that CSF research is very mature and approaching diminishing returns. However, potential still lies in micro-level approaches, longitudinal, and multi-level approaches to CSF research. We argue that current research has generally taken a macro perspective. We do not know whether there is a differential effect on users that is dependent either upon task type (e.g., accountant, factory worker, warehouse employee, etc.) or upon employee level (e.g., assembly line worker, supervisor, manager, vice president, etc.). A testable research question is to hypothesize that all CSF are important at all levels in the organization and across all task types. Multi-level research could investigate factors which promote ERP success at the individual user level compared to those of teams or other sub-units of the firm. ERP research has yet to sufficiently investigate micro issues such as factors unique to targeted ERP functionality (i.e., ERP module or extension). Do ERP CSF vary depending upon which type of ERP module was implemented (e.g., a financial ERP system/module, a manufacturing ERP system/module, a human resources ERP system/module, or some other functional area)? Much of the extant CSF research has reported on either financial systems or manufacturing systems, so it might be possible to conduct a meta-analysis to review insights.

Another research question is whether there are different CSF or different priorities among CSF when an organization upgrades or converts to a different ERP system. This research applies to organizations undergoing mergers or acquisitions where the acquired organization must now integrate operations by implementing the parent firm's ERP system. Since the current research does not even specify the levels or timing of the CSF, such research could help specify when and how the CSF should be applied in ERP reimplementation, providing a significant contribution to the literature.

Business Processes, Change Management, Education, and Acceptance

The research into ERP CSF repeatedly identified a number of areas that are associated with successful ERP implementations. In this section, we examine the areas of business process reengineering, change management, user education, and user acceptance.

Business Processes

Business process reengineering (Hammer and Champy 1993; Davenport and Stoddard 1994; Boudreau and Robey 1996; Davenport 1998) is frequently linked with ERP implementations

(Nah et al. 2001), as ERP systems embed business processes, thereby restricting and enforcing organizational routines. ERP implementation decisions determine the extent to which work processes will depart from past practices in favor of redesigned business processes or "best practices" (Huang et al. 2004; Wenrich and Ahmad 2009). Better techniques are needed to determine how business process design and ERP configuration decisions will impact future business operations and management control. Business process reengineering benefits of enterprise resource planning systems are often touted; however, the opportunities for continued process improvement after ERP implementation have rarely been explored (Martin and Cheung 2005). ERP systems embed and reinforce the execution of prescribed business routines. As stated in Butler and Gray (2006, 214), "routines are a double-edged sword. They are helpful when they provide options, but detrimental when they hinder detection of changes in the task or environment." Research into promoting mindfulness and continuous improvement in the use of ERP could help achieve a better balance between strictly following existing business processes and recognizing opportunities to evolve processes to more efficiency and competitiveness in an ever-changing competitive environment. When using process-aware systems such as an ERP, decisions are needed when activities do not proceed as expected within the instantiated ERP process. Such deviations can require changing the routing of work, changing the work distribution, or changing the requirements with respect to available information (van der Aalst et al. 2007). Such changes in use can affect or even subvert planned operational efficiencies and management controls. Research is needed to determine how the gap between the planned and actual activities can be reduced, and also to determine the methods for discovering when ERP configuration changes are beneficial. Business processes are a key element in a well-rounded change management strategy that should broadly consider diverse areas in ERP implementation, along with strategy, structure, culture, information technology, and managerial systems (Al-Mashari 2003).

As ERP installations mature and strategic benefits become realized (Holland and Light 2001), it is a practical matter that ERP upgrades and migrations become necessary. An expanded ERP research focus should include investigation of mature stages of ERP use, and look particularly at continual improvement through process reengineering in mature ERP installations.

Business process knowledge acquisition is a critical part of the educational effort needed in the ERP change management process. Recent innovations in business education seek to improve business process knowledge growth using real-time business simulations utilizing hands-on ERP usage (Léger 2006; Cronan et al. 2011). Business process knowledge is a part of the core knowledge base supporting ERP knowledge. ERP change management and educational research should look beyond ERP transaction skills (often the primary focus of traditional ERP training) to address understanding of other important business context factors, including business process knowledge, interdependent/cooperative tasks, and cross-functional problem-solving skills (Kang and Santhanam 2003). Research into knowledge acquisition in the ERP context can benefit from investigating novel knowledge measurement techniques such as knowledge structures (i.e., mental models) (Schmidt et al. 2011) and processing mining techniques. Future research directions should also utilize innovations in IS research techniques such as neuro-IS methods, which measure underlying physiological mental processing while using information systems (Pavlou et al. 2007; Dimoka and Davis 2008).

Process mining is a nascent approach to business process analysis which utilizes event logs of systems that support processes, especially workflow systems like ERP, which log numerous transactions and other events (Song and van der Aalst 2008). A primary goal of process mining is to extract knowledge from these logs to support a detailed investigation of real business operations. Process mining research is emerging as a way to improve understanding of actual business processes and as a means for objective observation of actual system activities in an audit situation. Emergent process mining approaches offer promising avenues to address the need to reveal actual

process execution (Jansen-Vullers et al. 2006), uncover underlying informal organizational structures (Song and van der Aalst 2008), and possibly to even project the impact of ERP configuration on various process activities (Dreiling et al. 2005).

Different approaches to process mining have been proposed which analyze predefined process model definitions to verify their correctness (Van Dongen et al. 2007) or analyze extracted transaction data to discover how actual processes are executed (Jansen-Vullers et al. 2006). Process mining is narrowly focused on process analysis, but is conceptually related in a broader context to Business (Process) Intelligence (BI) and Business Activity Monitoring (BAM), which view aggregated data from an external perspective. In contrast, process mining takes an internal perspective, investigating the detailed activities within the process, thus uncovering differences between envisioned processes and actual process execution (Song and van der Aalst 2008). Modeling existing business processes and modeling future ERP-based processes is a promising approach to anticipate longer-term impacts of ERP implementation decisions.

Change Management

Change management, a critical success factor for ERP implementations, builds on research in the organizational management and information systems disciplines. Organizational change management is a structured process to proactively manage individuals affected by the change, and recommends tactics including "readiness for change" assessments, training programs, job redesign, and organizational structures modifications. When IT is a major driver of the change, the IT literature further recommends technochange management, which pays particular attention to technology features and considers its effects in the change process (Markus 2004). A well designed and executed change management program is vital to addressing project risks in order to increase the potential for project success. ERP implementations have unique challenges beyond other information systems, including the simultaneous reengineering of business processes, investment in technology professionals, integrating external consultants and their application knowledge, risk of technological bottleneck in implementations, and recruiting and retaining personnel with technology and business knowledge (Grabski et al. 2001; Somers and Nelson 2001).

A recent review of risk management in ERP projects found the most frequent risks occurred in the early conceptual phase with the lack of strategic thinking and poor ERP selection, followed by the second set of risks including implementation problems of inadequate change management and lack of adequate training (Aloini et al. 2007). ERP change management studies include individual cases (Ross 1999; Lui and Chan 2008), comparative case studies (Robey et al. 2002), empirical studies assessing multiple firms' implementations using interviews (Gupta 2000; Markus et al. 2000; Benamati and Lederer 2008), and surveys (Al-Mashari 2003; Benamati and Lederer 2008; Bueno and Salmeron 2008).

The relationship between ERP systems and innovation from a knowledge-based perspective has been researched by Srivardhana and Pawlowski (2007). They built upon the multi-dimensional conceptualization of absorptive capacity and developed a theoretical framework that specified the relationship between ERP-related knowledge impacts and absorptive capacity for business process innovation. They viewed ERP systems as possessing dialectical contradictions that both enabled and constrained business process innovation. Park et al. (2007) also examined absorptive capacity and found that the capacities of users to assimilate and apply the knowledge had both direct and indirect effects on its value. Further, the users' effective knowledge acquisition and transfer to work tasks requires an understanding of newly acquired ERP knowledge within the new context and synthesized into the user's task environment.

ERP systems are intended to integrate, centralize, and optimize tools in support of business operations across the supply chain, both within and beyond the organization (Al-Mashari 2003). Change initiatives to reduce resistance and encourage effective usage of the new ERP system often

focus on process change management, sociotechnical, and educational approaches. The general business process change management framework shows process management as essential in end-to-end change management and emphasizes that IT should not drive the change process (Gupta 2000). Fundamental to ERP projects, process improvement consists of designing business procedures and ERP models to be consistent across business operations (Nah et al. 2001). An ERP process change-oriented model emphasizes the need for strategic alignment between the ERP system deployment and strategic management, as well as the strategic alignment between process improvement and strategic management. Further, the key elements of strategic management, process improvement, ERP system deployment, project organization, and organizational change management must all be considered and integrated (Al-Mashari 2003).

In anticipation of resistance from the intended end users, the sociotechnical systems design approach strives to jointly optimize technology and people when redesigning organizational structures and work processes (Taylor 1998). The benefits of this approach include motivating participants to embrace change by providing a clear strategic purpose and addressing the need to achieve work life quality as part of the change outcomes. Some researchers look to marketing research for models to motivate acceptance of ERP systems, much as consumers are motivated toward trying newly marketed products. For user resistance to be overcome, functional barriers of use, value, and risk, along with the psychological barriers of tradition and image, must be overcome (Ram and Sheth 1989). A process-oriented change framework has been proposed, consisting of the phases of knowledge formulation, strategy implementation, and status evaluation (Aladwani 2001). Others incorporate the guidance of Bridges and Bridges (2000), leading the transition to the new processes directed by the ERP system. The transition takes a significant period, as participants need to undergo three distinct processes: saying goodbye, shifting into neutral, and, finally, moving forward. Rose and Kræmmergaard (2006) studied an ERP system implementation based upon discourse theory, and were able to explain how the ERP project changed from a "classical" IT project to a technologically driven organizational change initiative.

User Education

Education and training are often the focus of ERP change management (Ip et al. 2004). Thus, change management can also be conceptualized from a primarily knowledge-based perspective. Several types of knowledge are needed for adapting to ERP-induced change, such as component knowledge (of one's job function and basic functions of application used to execute tasks) and architectural knowledge of the interlinking subsystems and interdependencies occurring based on change (Balogun and Jenkins 2003). The aim of education is to equip users to successfully utilize the system and motivate employees to accept ERP systems. Change management practice has long incorporated the need for education because it addresses both knowledge acquisition and behavioral change, as in Lewin's phased pattern of change involving unfreezing, moving, and refreezing (Schein 1996).

As many studies focus on the early phases of ERP selection and implementation, initial user training is often an antecedent variable to ERP success. Investigations of critical success factors often identified the user factors of training (Umble et al. 2003; Bueno and Salmeron 2008; Ngai et al. 2008) and communication (Holland and Light 1999; Amoako-Gyampah and Salam 2004) to be an antecedent to ERP implementation success and acceptance (Bueno and Salmeron 2008). Umble et al. (2003, 246) state that "reserving 10–15 percent of the total ERP implementation budget for training will give an organization an 80 percent chance of implementation success."

Training is a key antecedent of ERP's strategic fit in many different types of firms (Somers and Nelson 2003). In spite of the identification of the training as a critical factor, in-depth research into the specific knowledge required for effective ERP use is limited, and ERP implementations

often fail to provide adequate user training (Markus and Tanis 2000). Further, organizations that implement ERP systems fail to continue training and support after initial ERP use (Kang and Santhanam 2003).

In an ERP context, traditional information systems training approaches are not sufficient because adoption of an ERP system requires the implementation of cross-functional, integrated end-to-end business processes; it is not a simple application that only affects a single area. The ERP education process must include coverage of the collaborative nature of user tasks and the inter-related effects when a user fails to use the ERP system correctly. ERP systems are sometimes viewed as a disruptive innovation that implements a critical infrastructure rather than a software application (Jacobs and Bendoly 2003; Lyytinen and Rose 2003). In addition to learning technical operational skills, ERP systems users also need business process knowledge, cross-functional problem-solving skills, and an understanding of task interdependence (Sein et al. 1999; Sein and Santhanam 1999; Kang and Santhanam 2003). There is also the need for a broader scope of learning encompassing technology, operations, managerial, strategic, and organizational knowledge (Yu 2005). As collaborative workflow applications, ERP systems require learning across a full knowledge hierarchy, including application, business (motivational and contextual), and interdependency (task execution and problem-solving) knowledge (Sein et al. 1999; Kang and Santhanam 2003).

ERP training should not be viewed as a one-time preparation for initial ERP systems use, but rather an ongoing set of communications, educational opportunities (Yu 2005), and support for ongoing learning experiences with ERP (Kang and Santhanam 2003). Ongoing, experiential learning is valuable because it develops expertise in problem solving (Sein and Santhanam 1999) and adapting to novel situations (Orlikowski and Hofman 1997) in the dynamic and complex environment of an integrated enterprise. To achieve the productivity increases, users' knowledge must continue to expand after implementation (Kang and Santhanam 2003; Allen 2008; Santhanam et al. 2007). A holistic perspective on user and management education addresses training and education (Yu 2005) and change management (Orlikowski and Hofman 1997; Robey et al. 2002) across all phases of the ERP lifecycle.

New education approaches are needed due to the complex, integrated, and dynamic nature of ERP systems. Academics and leading ERP vendors have begun to develop ERP-specific training materials and to utilize innovative teaching methods. Recent innovations in ERP education include ERP e-learning techniques (Choi et al. 2007), training interaction with simulated ERP-like systems (Shtub 2001; Parush et al. 2002), and simulation game-based training on a live ERP system (Draijer and Schenk 2004; Léger 2006). Experiential ERP education utilizes a functional, dynamic ERP business environment to develop problem-solving skills, understanding of cross-functional operations, and to accelerate development of ERP expertise. It is important to determine which individual-level interventions are most beneficial to improve ERP acceptance and use. However, the extant research does not provide any indication as to how the individual-level ERP knowledge and performance aggregate into overall firm ERP benefits. An interesting research question is to examine what factors impact the relationship between individual performance and organizational performance, and to suggest approaches for organizations to improve performance through the application of individual-level education and training. Cross-level and multi-level research is also needed in this area. Future research should identify the set of knowledge, skills, and processes which contribute to ERP success at the individual, team, and organizational levels. It is likely that the interventions needed at one level are different from those needed on a different level. For example, what is appropriate for an individual might not be appropriate for a team; it may be that optimizing an individual's outcomes could result in sub-optimization on the team level.

User Acceptance

In general, the literature on ERP systems focuses on implementation and other technical issues such as efficiency, effectiveness, and business performance; there is a relative lack of attention given to the social context, that is, user acceptance, in determining the organizational consequences of ERP systems (Boudreau and Robey 2005; Dery et al. 2006a, 2006b; Grant et al. 2006). This is unfortunate, as social factors have been demonstrated to have the strongest significant effect on ERP system usage (Chang et al. 2008). Nonetheless, there is a growing body and variety of research that is best classified as sociological in nature, which focuses on human social structure and the interaction with ERP systems (Dery et al. 2006a). This is a diverse area, as ERP systems are people systems made possible by software and hardware (Wallace and Kremzar 2001). An increasing number of organizational studies of ERP systems are available. In general, case studies are used to examine the impact of ERP systems on organizational structure, job design, and organizational information flows (Koch 2001; Koch and Buhl 2001; Hall 2002; Robey et al. 2002; Boudreau and Robey 2005; Dery et al. 2006a, 2006b; Grant et al. 2006). Recent work also explores the "social construct" of the ERP system that is developed via a two-stage process: the incorporation of best practices into the ERP design in order to have organizational efficiency, followed by the customization by internal organizational specialists to allow the ERP system to work effectively within the organizational setting (Mayere et al. 2008). The social constructivist approach emerged in direct contrast to the technologically determinist methodology that dominates the study of ERP systems (Orlikowski 2000; Orlikowski and Barley 2001; Dery et al. 2006b; Grant et al. 2006).

Based upon the reviewed literature on business processes, change management, user training, and user acceptance of ERP systems, a number of questions for further research can be developed. First, there is a lack of longitudinal studies. In general, the research has been at a single point in time. Such research is a good foundation, but ongoing knowledge and skill development are important to ERP success. More focus is needed on revisions after the initial interventions are applied and to identify opportunities for "learning in use" and ongoing education. Longitudinal research would report on the long-term effects of these interventions, as well as offer insights into learning processes throughout the ERP usage lifecycle.

From a business process perspective, we do not know how to identify when ERP workarounds are enacted by a user, nor can we tell when there is inefficient use of ERP systems. There is a growing need to examine how resistance to ERP and ERP workarounds change over time, what actions management can use to counteract them, and how these ERP workarounds impact management control. Such research could help develop initiatives and approaches to modify user behavior and improve ERP usage and acceptance. This would likely occur through improved user education and the availability of "just in time" training for the users. If research could identify the inefficient and ineffective use of ERP systems, then the most appropriate approach for changing user behavior becomes a researchable question. However, a more basic question remains: how should training in ERP systems be optimally addressed? Are there any advantages in treating training as ongoing process and integrating training with ongoing technical support functions (Sein et al. 1999; Kang and Santhanam 2003; Santhanam et al. 2007)? Can the collaborative application hierarchy
(Sein et al. 1999; Kang and Santhanam 2003) be utilized as a framework to develop and test hypotheses about innovative educational and change management methods for ERP?

Post-Implementation Phases

Recent reviews (Esteves and Pastor 2001; Jacobs and Bendoly 2003; Botta-Genoulaz et al. 2005; Esteves and Bohorquez 2007; Moon 2007) indicate that a majority of ERP research focuses on ERP selection, success factors, and the implementation phase, but seldom on post-

implementation impacts. This highlights a critical research gap, as there is a great need for continued improvement and assessment as ERP use evolves over time. On the most basic level of post-implementation review, too often, the organization fails to identify benchmarks prior to implementation, it fails to gather "in use" metrics, and the organization subsequently has no basis for assessing the operational phases of ERP.

Nicolaou (2004) examined the process of ERP system post-implementation review. Based upon prior research and a case study of two firms, the research postulated that the post-implementation review moderated the success of the ERP project, and a conceptual framework of post-implementation review quality was developed. Building on that study, Nicolaou and Bhattacharya (2008) considered the post-implementation review factors and demonstrated that the use of post-implementation review activities resulted in improved differential performance when those activities were performed shortly after system implementation. Consistent with Nicolaou and Bhattacharya (2006), they report late post-implementation review activities have a negative impact on short-term profitability.

While they did not directly address post-implementation, Grabski et al. (2009) identified several organizations that had not obtained the level of success with their ERP system as they had originally desired. The research found that in order to obtain success, the ERP system and the way the system was used needed to be changed. A different approach was taken by Muscatello and Parente (2008). They concur that there is very little research focused on post-implementation efforts. They sought to understand, via a series of case studies of manufacturing firms, the processes and programs that changed during the post-implementation period that allowed those organizations to improve their performance. They developed a series of eight propositions that focus on the needed business process changes resulting from the ERP implementation. Future research should examine how business process change is managed in the ERP post-implementation phase and the relationship among process, organizational, and ERP technical changes.

While many ERP-specific lifecycle models have been described, a widely accepted information systems lifecycle model identifies the phases of initiation, adoption, adaptation, acceptance, routinize, and infusion (Cooper and Zmud 1990).This model can provide a broad framework for the investigation of long-term system maturity and evolution issues. As ERP lifecycle-based research is beginning to reveal, many motivations and factors change over the full lifespan of an enterprise system's existence within an organization. An enterprise system's life spans years and even decades, from ERP selection during the project initiation phase (Kumar et al. 2003), to business process reengineering in the adoption phase (Boudreau and Robey 1996), through the later phases of adaptation, acceptance, routine use, until managers consider whether to optimize or upgrade their ERP system (Khoo and Robey 2007). Markus and Tanis (2000) state that organizations experience problems at all phases of the ERP system lifecycle. Most alarming is that many problems occurring in later phases originated earlier, but were either unnoticed or not corrected. Markus et al. (2000) suggests that researchers employ multiple measures of success that span the system lifecycle and address problem detection, root cause analysis, and early correction. Peslak et al. (2007) also studied preferred ERP use and found that only certain lifecycle phases were influential. What is known is that success in one phase does not guarantee success in later phases. Future research should help organizations determine what they should measure and monitor as key performance indicators throughout the lifecycle of ERP. This will allow the organizations a well-thought-out approach for assessing and managing ERP post-implementation success. Research should also investigate what is needed for an organization to move from a relatively poor ERP implementation to more successful post-implementation stages. Research has indicated that this is possible (Grabski et al. 2009), but has not presented sufficient guidance as to how this should be done.

The number and scale of ERP installations increased dramatically in the last decade and now existing installations are maturing. Seldom studied in the past, ERP system maintenance and upgrades need to be addressed to understand the longer-term impacts on organizations and users. For ERP customers, maintenance and upgrade costs increase with greater customization and integration with legacy systems (Koch 2002; Beatty and Williams 2006). Yet, a study of ERP lifecycle phases did not find that the later maintenance phases exert influence on individual usage (Peslak et al. 2007). A fertile area of research is the dynamics and power relationships between vendors and companies during the post-implementation phases. What are the customer and the vendor perspectives regarding ongoing upgrades and maintenance of ERP systems? How much BPR is undertaken when ERP upgrades and maintenance changes are accepted into the firm? What is the extent and costs related to reactive planning and ERP investments as organizations are driven to upgrade on schedules dictated by vendors?

The current research has not adequately addressed the issue of the long-term impact on an organization and users when ERP system maintenance and upgrades are either selectively chosen by the organization or are mandated by the vendor. With a growing need for firms to successfully manage ongoing maintenance and upgrade issues, the general advice available (Koch 2002; Beatty and Williams 2006) needs to be supported and refined through new research in this growing area. Such research could address the customer as well as the vendor perspectives. An ERP maintenance and upgrade taxonomy (Ng 2001) and a model for maintenance and upgrade decisions (Sahin and Zahedi 2001) provide foundations for much-needed future research in this area. Newer ERP options raise more questions, such as the issues surrounding use of open source ERP software or of changing from an institution-based in-house ERP installation to an outsourced or hosted "software as a service" ERP instance. While there has been some research associated with the post-implementation phase of ERP implementations, this is an area that could benefit from additional investigation, especially as mature ERP implementations are very prevalent in industry today.

III. ORGANIZATIONAL IMPACT

In this section, we review the literature that strives to identify the organizational-level impacts of an ERP system. Increasingly, theories applied to the ERP domain acknowledge effects on organizations from the interaction between the social and technical nature of ERP systems. Just as ERP-related change influences individual employees (requiring change management strategies), it can also alter the nature and culture of the organization itself.

Organizational Change

Applying an IT technochange approach to ERP and its related organizational impacts predicts that each lifecycle phase involves both new IT functionality and related organizational changes, such as redesigned business processes, new performance metrics, and training (Markus 2004). The existence of a feedback loop between information technology design and the organization has been hypothesized in situations where the ERP system configuration implemented might be shaped by the local users and *vice versa* (Light and Wagner 2006). ERP systems are seen as a configurational technology, and an iterative process exists between the ERP system shaping the organization and individuals responding to problematic design choices by pushing for customization once the system has gone live. While a sociotechnical lens is used to explain the negotiations for changes to the user interface and functionality to the ERP system, it is normal for any ERP implementation to have a series of modifications made after the system has been implemented and used. It is impossible to test all of the end cases, and it is highly unlikely to anticipate all of the ways the system will be used. Light and Wagner (2006), in their study of two organizations, suggest that creating a successful ERP system is more likely when the design takes into consideration the diversity in perspectives on sociotechnical integration. Old practices should not nec-

essarily be eliminated; rather, valued existing practices should be selectively incorporated into the ERP system. This research suggests that the blanket approach of ERP as an agent of organizational change be reconsidered, that organizations should be aware of the benefits of selective maintenance of the status quo.

Ke and Wei (2008) theorized about the impact of top management and organizational culture on ERP implementation, and they develop a series of propositions relating ERP implementation success to organizational culture and strategic decisions made by top management. ERP success is dependent upon how well the ERP system matches the organizational culture. Additionally, some research suggests that the organizational culture can be modified by top management, especially when transformational leaders are in place (Senge 1994; Vera and Crossan 2004). Consequently, the success of the ERP implementation is related to the organizational culture as it relates to learning, participative decision-making, power sharing, support and collaboration, and risk and conflict tolerance, and how a desired culture can be fostered by top management (Ke and Wei 2008). In a recent one-year study of the impact of ERP implementation on employee job characteristics, a contingent relationship is found between ERP implementation and the job characteristics of skill variety, autonomy, and feedback in Hackman and Oldham's (1980) job characteristics model. This research indicates that ERP systems influence job redesign and the selection of organizational change strategies (Morris and Venkatesh 2010).

Various theoretical approaches have been used in studies of the effects of ERP systems on organizational change. A unique approach was used by Rikhardsson and Kræmmergaard (2006) in their study of the use of ERP systems by six Danish organizations. The research uses an exploratory design approach based upon the principles of hermeneutics and grounded theory (Glaser and Strauss 1999). The approach used allows the manager to recall and gather information while completing their case that might not be available during a single interview period. The ERP system resulted in changes to the organizational structure, changes to the communication patterns, and changes to business processes. While the extant literature acknowledges and expects process changes (i.e., the need for business process reengineering), the former changes are generally unexpected.

An alternative approach critically evaluates the relationship between ERP systems and organizational power relations. This approach considers the implications of ERP systems on skills, autonomy, control, and the experience of work, and often provides an analysis of the reasons for resistance to technological change (Dery et al. 2006a; Hall 2005; Dillard et al. 2005; Arnold et al. 2000). A pragmatic interventionist perspective uses methods such as discourse theory and analysis and situated practice (Dery et al. 2006a). Advocates of this approach believe that it provides an opportunity for appreciating the relationship between ERP systems and people, and how people use ERP systems (Orlikowski 2000).

A resource-based model of competitive advantage was used by Beard and Sumner (2004) to examine whether ERP systems provide a competitive advantage based upon the premises of system value, distribution, and imitability. Consistent with Mata et al. (1995), they proposed that effectively exploiting an ERP system depends upon successful project planning, implementation, alignment, and utilization, so that competitive advantage can be achieved through the management of ERP projects and subsequent ERP use. Boudreau and Robey (2005) use human agency theory to help explain ERP system resistance and use in both intended and unintended ways, while Ignatiadis and Nandhakumar (2007) use it to help explain how users overcame programmed procedures (i.e., drifted away from desired corporate outcomes) in order utilize the ERP system at their local areas. Also, it was used to explain the presence of improvised learning of the ERP system (Orlikowski and Hofman 1997; Elbanna 2006).

The body of sociological research related to ERP system implementation and use is of growing interest as ERP systems are designed and used by interdependent groups of individuals striving

for shared organizational goals, and individuals need to make sense of the technology and how best to utilize it. When the system results in deficiencies, individuals create unique solutions (Groleau 2008). As noted in this section, there are a variety of theoretical approaches that can be used, and this appears to be a fruitful venue for future research. Some of the key papers in the area of organizational impacts are presented in Table 3 of the online resources. Some questions for future research on the organizational impact of ERP systems include exploring the relative value between technology-centric and organizational/social theories in explaining the ERP-related organizational outcomes, and investigating other theories to explore the relationships between ERP systems and organizational change. More research is needed into how organizational culture and ERP technology interactively influence ERP organizational change strategies, the need for new expertise (technical and nontechnical), and the nature of job characteristics and task interdependencies.

Organizational Control Strategies

ERP systems have a variety of effects on the organization. They can be used to help improve decision-making (improved decision-making is often used as a significant nonquantifiable benefit when an organization proposes implementing an ERP system) and also be used as a catalyst to restructure the organization (since information can now be easily shared, the organization structure can be flattened). As individuals learn how to use the ERP systems, they often discover ways to use the system that were not anticipated by the system designers. Other times, the users feel that they have lost whatever control they originally had over their work environment. In this section, we review the literature surrounding the use of decision support via ERP systems and managerial control systems.

Decision Support and Business Intelligence

ERP systems are integrated and comprehensive enterprise recordkeeping systems. Decision support systems (DSS) and business intelligence (BI) systems, i.e., analytical systems, are designed to support decision-making, either through various generalized or specialized decision aids or through the examination of significant volumes of data coupled with the appropriate programming (intelligence) to help generate valuable information for decision-making (Chou et al. 2005; Holsapple and Sena 2005). Customer relationship management (CRM) and supply chain management (SCM) systems are often considered to be a DSS rather than an ERP system (Shafiei and Sundaram 2004). There is also an emerging research stream on Business Analytics (Davenport 2006; Davenport and Harris 2007).

ERP systems, while not a DSS based upon traditional definitions, offer substantial decision support benefits due to the integrated database inherent in ERP systems (Holsapple and Sena 2005). At least one study found that ERP adopters perceive their ERP system to provide significant decision-support characteristics, and these DSS characteristics are considered valuable (Holsapple and Sena 2003). To realize the full benefits of centralized information and use of integrated systems, ERPs are also often augmented with BI and other analytics applications. Management must provide some guidelines as to the type of questions it will want answered, as the ERP system is transaction-based and is built on a database that can consist of thousands of tables (Zhao and Shi 2008), whereas the BI system is query-based and is built on a data warehouse (database) that needs to be optimized for various BI-oriented queries.

Organizational benefits can be accrued when DSS are used in a collaborative manner by using integrated ERP and DSS, such as CRM and SCM (Shafiei and Sundaram 2004). This integration can be accomplished with Enterprise Application Integration (EAI) technology. EAI is able to integrate various types of enterprise applications (e.g., legacy, custom) (Lee et al. 2003; Shafiei and Sundaram 2004). ERP is viewed as supporting a centralized business strategy, whereas EAI

enables decentralized business processes (Lee et al. 2003). The use of enterprise application integration (EAI) as an appropriate mechanism to help comply with SOX requirements within an SAP environment has been suggested (Maurizio et al. 2007). More research is needed into the risk and compliance tradeoffs between customizing to support existing business processes versus implementing "best practice" ERP systems.

Some believe that business intelligence is a necessary component in ERP systems, including CRM and e-commerce components (Carlsson and Turban 2002). The relationship between data warehousing and other BI-related tools and strategic decision-making needs additional research (March and Hevner 2007). The same can be said about the relationship among ERP systems, decision support systems, business intelligence systems, and strategic decision-making. There is limited research, and most of it is related to the development of conceptual models such as Shafiei and Sundaram (2004) and Chou et al. (2005). BI systems require an organization to plan how the ERP system should be integrated with the BI system. A fundamental question is whether ERP systems lead to actual use of these advanced forms of decision support or whether users work around the technology. If they do use the technology, then the research should examine the behavioral effects on decision-making by users of integrating DSS/BI and Strategic Enterprise Management (SEM) with ERP systems. A key question is whether the decisions are dominated by the technology available or whether the decision-making process actually improves.

Much of this research on ERP BI/DSS/Business Analytics has been either conceptual in nature (e.g., development of a conceptual integration model) or more technical in nature (e.g., explaining EAI). The strategic impact of any information technology is dependent upon how well it is introduced into the organization (Benamati and Lederer 2008). Many questions remain, such as what are the BI/DSS/Business Analytics and ERP implementation issues faced by organizations during integration and use of these tools? Where in the ERP design and implementation process should business intelligence and decision support tools be introduced? What are the strategic and control benefits from the integration of DSS/BI/SEMs with ERP systems? How frequently does the use of ERP systems lead to usage of, and benefits from, DSS/BI/SEMs? There is limited research (either case study or cross-sectional) that demonstrates the benefits obtained from the integration of ERP and BI/DSS. Research is needed to develop ways to ensure and measure the strategic and operational benefits obtained from the integration of ERP and BI/DSS. A simple way to examine the impact of a BI/DSS tool is to ascertain whether there is a reduction in the number of shadow systems after an ERP implementation when a BI/DSS tool is implemented. Finally, there is virtually no research related to the behavioral or sociological view of the use of BI/DSS tools. This is an under-researched area that deserves more attention.

Management Control Systems

The impact of ERP systems on management accounting and on management accountants has been the focus of a considerable amount of research with mixed results. In Rom and Rohde's (2007) review of related literature, they report that the role of management accounting is becoming increasingly dispersed in the organization and that an understanding of the relationship between ERP systems and the design of management accounting techniques is lacking. Scapens and Jazayeri (2003) found that characteristics of the ERP system (specifically, its integration, standardization, routinization, and centralization) reduced the routine management accounting work, provided line managers with more accounting information, and gave management access to more forward-looking information—all of which provided opportunities and facilitated change among managerial accountants.

A fundamental benefit of ERP systems is data integration through a centralized data repository for the entire firm which, in turn, could allow each user direct access to any piece of available system information (depending on their system user knowledge, role, and system access privi-

leges). On the positive side, data integration via ERP is found to improve information quality (Häkkinen and Hilmola 2008) and can enable management control leading to perceived ERP system success and business unit performance (Chapman and Kihn 2009). However, data integration also enables pervasive (and possibly unfettered) access to corporate data if the appropriate controls and access privileges are not in place. Yet, Granlund and Malmi (2002, 299) concluded that "ERP projects have led to relatively small changes in management accounting and control techniques." So far, a general consensus is that ERP systems have had little impact on the practice of management accounting, but the role of the management accountant in an ERP environment is evolving into a business consultant (Booth et al. 2000; Caglio 2003; Rom and Rohde 2006, 2007).

Adoption of ERP systems raises a paradox with respect to management control, as ERP systems can place limitations on future managerial control choices. How an ERP is configured initially can have long-term impacts and restrictions on the organization, particularly on management control. Field studies illustrate this issue by reevaluating organizational integration and control in an ERP context. Dechow and Mouritsen (2005) differentiate between ERP as a integrated database versus ERP as a broader system impacting management controls long-term based on early configuration decisions. It is not easy to anticipate the long-term implications of initial ERP configuration decisions which could limit or could facilitate the organization in achieving desired management controls, in ways often not predicted during the implementation phase (Quattrone and Hopper 2005).

There is an increasing need for better techniques to determine how ERP configuration decisions influence future managerial control options. A gap exists in assessing the economic value, organizational impact, and long-term implications of ERP-based distributed managerial control, as well as how accounting's role should best evolve to ensuring effectiveness of managerial controls. Research is needed to examine the long-term impacts of ERP configuration decisions, including the process of selecting ERP configuration design options and for predicting their long-term implications. The challenge is to overcome differences of perspective, knowledge base, and communication that arise across different levels and expertise across the enterprise. Dreiling et al. (2005) point out the need for simultaneously representing different perspectives during ERP configuration design. The recommendation is to span differing perspectives of management, business process analyst, and technical analyst based on use of conceptual modeling for the purpose of ERP configuration.

Interestingly, Rom and Rohde (2006) found that Strategic Enterprise Management (SEM) systems had a positive impact on management accounting practices, whereas ERP systems only had a positive impact on transactional management accounting (e.g., data collection). Examining SEM from the perspective of management accounting and control activities, Fahy (2001) concluded that ERP vendors generally perceived SEM to be a technological issue rather than a management or decision support issue. These findings are supported by Brignall and Ballantine (2004), who stressed the need for considering the broader needs of organization to achieve implementation success. This is consistent with the requirement of a strategic perspective for the implementation of an ERP system, a necessary but not sufficient condition for a successful implementation (Grabski et al. 2001).

Various organizations have anecdotally reported a reduction in the number of management accountants as the result of an ERP implementation. However, in at least one setting, accountants are attempting to redefine their role relative to ERP systems (El Sayed 2006). Accountants are promoting themselves as relevant experts, using the introduction of an ERP system to assert their skills and knowledge as having broader importance to the firm. Nonetheless, other prior research has documented that ERP systems have had only limited impact on managerial accounting and management accountants (Granlund and Malmi 2002; Scapens and Jazayeri 2003). Grabski et al. (2009) provide insight into these surprising results and report that only under certain conditions is

there a marked change in the tasks performed by the management accountants. Grabski et al. (2009) demonstrated that organizations with successful ERP implementations had differential tasks performed by managerial accountants relative to those that had less-than-successful ERP implementations.

We still have limited knowledge related to the impact of ERP systems on management control systems and management accountants. The primary unanswered research questions center on determining how an ERP system's strategic and control benefits can be achieved to realize firm efficiencies, enhance agility and problem solving, and support firm strategy. While much has been learnt, many unanswered issues remain.

Risk Management and Regulatory Issues

Risk can be defined as a problem that has not occurred, but has the potential to cause loss or to threaten the success of a project (Sumner 2000), or as the likelihood that the outcomes from a process will not meet expectations (O'Donnell 2005). An ERP implementation has often been identified as having high risk and as an important area of study in large and SME firms (Poba-Nzaou et al. 2008). Yet, ERP systems offer many advantages for risk management, such as internal controls, an enhanced audit trail, along with compliance and governance extensions. For these reasons, many firms anticipate benefits in compliance and risk management areas from ERP. Notable trends in risk management and regulatory research address security and internal control issues, the need for ERP audit techniques (such as embedded audit modules and continuous audit support), as well as other ERP extensions to address regulatory demands such as XBRL reporting and IFRS. The Sarbanes-Oxley Act (SOX) of 2002 greatly expanded the need for IS security and internal control compliance. Many other regulations and requirements, such as the Health Insurance Portability and Accountability Act (HIPAA) and IS audit requirements from ISACA, continue to emerge to affect companies utilizing ERP systems. ERP use in multi-national companies also makes it subject to diverse international regulations.

ERP's often-cited role as a leading technology to address business risks, regulatory compliance, and offer strategic advantages is positioning this technology into the attention of top management and the board of directors, slowly evolving IT governance from the sole responsibility of the CIO to that of the CEO and board. More IT governance decisions should be led by the CEO and the board in strategic partnership with the CIO (Willcocks and Sykes 2000), as top management increasingly leverages ERP for risk management, regulatory compliance, inter-organizational alliances, and longer-term strategic initiatives (e.g., DSS/BI/Analytics). The taxonomy of IT governance identifies five primary areas: strategic alignment, risk management, resource management, value delivery, and performance management (Wilkin and Chenhall 2010). With its broad functionality, business process integration, and extensibility, ERP is increasingly involved in all five areas of concern of IT governance. While ERP research has emphasized some topics in IT governance, much work remains to address overall ERP governance needs, identify ERP governance "best practices," and elevate oversight of ERP seamlessly into business strategy and overall governance. IT governance research is needed to guide ERP's evolution in this area.

Sayana (2004) points out that ERP systems automate many functions and support seamless data collection from the start to the end of a business process. These operational characteristics eliminate intermediate verification of data and documents between steps in a business process. Therefore, in ERP systems, all data need to be accurate and authentic at every step in the business cycle, and configurations which automate processes and controls must be carefully scrutinized. Often, ERP extensions expand the technical capabilities of ERP systems to meet the evolving demands of business. The Securities and Exchange Commission's (SEC) recent requirement to

support XBRL formats (SEC 2010) for financial reports has motivated creation of new ERP reporting extensions. Risk management and regulatory pressures require enacting new forms of security, controls, and audit. Each topic is reviewed in this section.

Security and Internal Control

The implementation of ERP systems may prove as significant to accounting practice as the transitions to database management systems and electronic data interchange (EDI) systems (Williams 1992). In 2009, security, privacy, and other information control issues headed the list of the American Institute of Certified Public Accountants' (AICPA) top technology issues, as it has for many years now (Walters 2007; AICPA 2009). ERP technology does not impose a specific control structure, but neither can controls be analyzed independently of the technology or its context of use. Management control in ERP becomes a collective activity as control issues are distributed to different areas of the organization (Dechow and Mouritsen 2005). Risks inherent in using ERP systems can be classified into four categories: security, control, system, and business risks. Security risks are associated with unauthorized access to information systems. Control risks are risks which affect the enterprise's policies or procedures, particularly those related to internal controls of financial data (Hsu et al. 2006). The role of system risks to financial reporting continues to grow due to the pervasive reliance on information systems. Heightened segregation of duties risk occurs in ERP systems due to the interconnectivity, integration, and automation of business processes, whereby one individual's single data entry can trigger actions across several interconnected processes (Hsu et al. 2006). Configuration choices made during ERP implementation directly affect controls, as well as the degree of change to business processes and job roles in the firm. Findings are mixed, with some literature indicating that ERP systems can increase overall control risk (Wah 2000; Hunton et al. 2004).

ERP systems present unique risks because of tightly interlinked business processes, process reengineering, centralized relational database, and customization through configuration choices and extensions from integrating ERP with other applications. Key ERP systems characteristics that impact security and internal control include degree of standardization, centralization, authorization, and access to ERP functions, as well as automation of controls versus existing internal control structure (Scapens and Jazayeri 2003). There is a risk that control mechanisms will not be effective if internal process linkages are not set up or if integrated internal controls are bypassed (O'Leary 2000). A centralized, integrated ERP provides a single point of control segmentation for segregation of duties (SOD), but also provides opportunities for inappropriately configured access privileges to violate internal control guidelines. With hundreds or thousands of individual users accessing the company ERP system, testing SOD is challenging, and often separate SOD testing tools are used (Lightle and Vallario 2003).

An important research finding is that ERP systems-based firms rarely determine the effectiveness of security and control by auditing system outputs (only 9 percent of firms). Rather, ERP firms predominantly used process audits (77 percent) and reviews of controls (95.5 percent) to ensure ERP systems security and controls (Wright and Wright 2002). Managers point to the critical need for auditor involvement during the implementation process and user training to avoid errors, which rapidly proliferate through the system and then require extensive efforts of collaborative problem-solving to resolve (Wright and Wright 2002).

In a study of audit risk assessments, both financial auditors and IT auditors recognized a heightened degree of risk in business interruption, process interdependency, and overall control risks with ERP versus non-ERP systems. Of great concern are the findings that financial auditors did not recognize the heightened degree of risk in ERP systems regarding network security, database security, and application security, whereas IS experts did (Hunton et al. 2004). This

suggests that financial audits are likely to underestimate ERP systems risks, indicating that ERP audits are best performed by a cross-functional team of auditors and IS experts.

Kumar et al. (2008) examined the extent to which ERP systems meet regulatory internal control requirements. Simply using ERP does not ensure adequate controls are implemented. Companies implementing controls for SOX compliance faced technical, cultural, and process issues. The control implementations were lengthy and costly, with all organizations spending significant time documenting their control systems. Significant modifications were needed in standard modules in two of the organizations. Increased controls led to significant resistance in all four organizations, as has been seen in many ERP implementations (Elmes et al. 2005; Ignatiadis and Nandhakumar 2009). Kumar et al.'s (2008) study found that the primary reasons for user resistance in an ERP implementation were loss of data access, loss of authority and increased restrictions. Elmes et al. (2005) identified two self-contradictory themes in ERP implementations: panoptic empowerment and reflective conformity. The concept of panoptic empowerment conveys that ERP simultaneously provides increased observation of tasks while also providing access to real-time information that enables users to act more autonomously. Reflective conformity conveys how ERP enforces adherence to business processes while encouraging users to reflect on how to perform their tasks more efficiently and innovatively (Elmes et al. 2005).

Four main aspects of a secure system are authentication, authorization, integrity, and auditability. With ERP, authentication and access control are even more important than ever, due to the broad scope of information directly accessible to a single user. This should lead to stricter forms of authentication which verify the individual's identity (Chandra and Calderon 2003) and increased automated auditing of access controls. ERP access authorization based on profiles is a flexible and powerful mechanism for role-based and transaction-based access definitions (van de Riet et al. 1998). At the same time, inappropriate configuration of this flexible access control mechanism also allows inadequate configurations that fail to provide sufficient access controls and segregation of duties. Hidden and complex, these mechanisms create greater complexity for control and audit.

The use of complex ERP systems and a heightened awareness of IS reliability risks have already increased reliance on audit team group decision-making, especially in the control assessment process (Carnaghan 2000; O'Donnell et al. 2000a, 2000b). To address these needs, ERP vendors are now providing compliance applications to support access control, compliance auditing, and handle various risk management activities (Baseline 2005). What do these ERP governance and compliance extensions contribute to the firm's governance and compliance efforts? Are there other related benefits, such as internal financial benefits, compliance benefits, security, and fraud benefits? What are the potential risks and longer-term implications of individualized customization and configuration parameters in efforts to ensure higher degrees of ERP system assurance, compliance, and security? (i.e., can ERP risks be identified at a more detailed, configuration feature-level basis?)

Research into longer-term effects of compliance initiatives would benefit from a longitudinal study of effectiveness and efficiencies (cost-benefit analysis). Existing security mechanisms can also be adapted to perform new auditing and compliance-monitoring functions. For example, intrusion detection systems can be adapted to identify illegitimate ERP access or transactions (O'Leary 1992). What are the cost and the value of adapting security mechanisms to implement internal controls and compliance needs? Many issues remain, including how to evaluate the adequacy of existing ERP internal control mechanisms and what is the requisite knowledge to effectively configure secure ERP systems.

Future research in this area could evaluate the adequacy of existing ERP control mechanisms in implementation strategies. This research area is still quite undeveloped relative to criticalness of this topic in both research and practice. ERP systems are a central part of a set of interacting

information communication technologies which have become so highly integrated and complex that it continues getting more and more difficult to assess, much less to ensure, a high level of security and internal control.

ERP Audit Support

ERP systems increase the opportunities for automatically auditing corporate accounting information through data centralization and enhanced direct access to transaction details, and pressure to provide continuous auditing is increasing. The American Institute of Certified Public Accountants (AICPA) has encouraged a move toward continuous auditing, also known as real-time accounting (RTA) (Zhao et al. 2004), and electronic auditing (EA) (Liang et al. 2001). SOX legislation has motivated many firms to adopt ERP systems as part of their compliance strategy, partially due to its support for internal controls (Maurizio et al. 2007; Kumar et al. 2008). Yet, adoption of ERP for security and compliance could backfire, as audit complexity increases rather than decreases when auditors lack the requisite ERP knowledge and Computer Assisted Audit Tools (CAAT). The large volume of business data collected in the central repository of an ERP system can only be adequately audited with expanded auditing skills and enhanced audit support tools with powerful data extraction and analysis features (Kilpatrick 2000). Several vendors now offer CAATs developed specifically for the ERP environment, including IDEA (Kilpatrick 2000), Searchspace, TransactionVision (Deshmukh 2006), Virsa (Westervelt 2006), and ACL (ACL 2010). An implementation study of the monitoring and control layer for a continuous monitoring system at Siemens Corporation found that it is feasible to formalize audit procedures and audit judgment. This study developed a hierarchical approach to the structure of audit alarms and a role-based approach to assignment alarm identification (Alles et al. 2006). Yet, exploratory research reveals limited support for ERP embedded audit modules (EAM) for fraud prevention and detection among several leading ERP vendors (Debreceny et al. 2005). While vendors claim EAMs are technically feasible, currently the limited availability is based on a lack of demand from the user community.

Chang et al. (2008) developed a prototype computer auditing system for an Oracle ERP expenditure cycle based on a software quality assessment criteria model. System validation was accomplished through a case study of two organizations whose informants found the system was useful and facilitated internal controls. The system enabled users (both management and external auditors) to identify incorrect financial statements and fraudulent activities. This research suggests that the combined knowledge of accounting and information technology yields better performance in an ERP environment.

Future research should address the scope, level of automation, and reliability that can be achieved utilizing ERP embedded security and control features along with external CAATs. The current research does not provide sufficient guidance as to the availability of CAATs and EAM. Further, there are limited reports of the use of CAATs and the usefulness and effectiveness of these CAATs is unknown. Can specific CAATs aid ERP audits? Can guidelines for the effective use of CAATs be identified? Nascent ERP literature has yet to adequately investigate the role and impact of CAAT and ERP audit-related features or identify best practices for continuous audit and standardization of audit features. These topics are promising areas for targeted research. Future research is also needed into how the computer-based audit support systems and decision aids developed in-house by the major international audit firms cope with the interrelated transactions from complex (and often global) ERP systems.

ERP Extension for Extensible Business Reporting Language (XBRL) and International Financial Reporting Standards (IFRS)

The accounting discipline is placing new demands on ERP systems in order to support new standards and automate support of financial reporting. A recent extension for ERP is the need to

support automated identification and online transfer of financial reporting data. In May 2008, a new SEC rule proposal mandated use of the eXtensible Markup language (XBRL) for financial disclosures on company websites by late 2008 for most U.S. Fortune 500 companies. XBRL is also being adopted by European regulators as a standard (Locke and Lowe 2007a). Issues related to the use of XBRL and international accounting standards in the European community have also been identified (Bonsón 2001). Recent studies assessed the validity of the XBRL taxonomy (Bovee et al. 2002), the feasibility of automating translation of 10-Q and 10-K filings into XBRL format (Bovee et al. 2002), along with the costs and benefits of supporting XBRL as a reporting standard (Bonsón 2001; Pinsker and Li 2008).

Many firms believe that benefits will outweigh the cost to convert (Bonsón 2001); however, many are underestimating the ease of conversion (Pinsker and Li 2008). Barriers to adoption include evolving standards, lack of knowledge of XBRL among accountants and financial experts (Hannon 2004), as well as varying speeds of adoption across countries (Bonsón 2001; Abdullah et al. 2008) and industries. The issues related to ERP systems and the use of XBRL relate to the ease of extracting and converting/tagging the data from within the ERP system, but are likely to have much broader implications when viewed as a sociotechnical object (Locke and Lowe 2007b). Some researchers argue that XBRL is simply a reporting mechanism that is applied to extracted data, and as such should not be a significant issue for ERP system use. Others believe that in order for benefits to be obtained, the tagging needs to occur at the transaction level, which would require significant changes to ERP systems. The emergence of additional XBRL standards such as XBRL-GL (which supports XML tags with financially meaningful labels for the general ledger accounts) offers the opportunity to move upstream from external financial reports and to reach deeper into accounting systems, potentially to the point of tagging each transaction. This opportunity raises issues about the role of ERP systems in utilizing XBRL from the initial transaction, tracing through accounts to the general ledger and feeding external financial reports. Research into the value of extensive use of XBRL tags at different levels of accounts would help guide adoption decisions. It would be helpful to understand the extent of ERP extensions for XBRL and how effective XBRL extensions are perceived to be. XBRL research closely related to ERP systems could address the effectiveness of automation for creating, disseminating, and utilizing/analyzing XBRL-formatted financial data. Such studies should consider the broader usefulness of standard electronic availability of financial data beyond financial reporting to include taxation, intra-organizational communication and value chain, and new opportunities for business intelligence enhanced by linking firm financial data to other industry and international economic data.

Many firms are now also faced with preparing financial statements that adhere to both International Financial Reporting Standards (IFRS) and some other domestic set of financial reporting standards. This has resulted in the need to modify and extend the ERP system. As of yet, there is minimal academic research related to IFRS and ERP systems. Key issues include identifying best practices for implementing IFRS within ERP systems and determining how the use of IFRS will drive changes in audit and control procedures associated with ERP systems.

Evolutionary Changes in ERP

Recently, firms have begun to seek efficiencies by integrating systems among supply chain partners with ERP systems as key components in an Inter-Organizational System (IOS). For example, an integrated supply chain management (SCM) system would typically include the components of procurement applications, inventory management systems, demand planning and manufacturing execution systems, transportation planning and execution systems, warehouse management systems, customer relationship management systems, and sales force automation systems (Siau and Tian 2004). According to Siau and Tian (2004), an ideal integrated supply chain should have the characteristics of covering all stages of the information supply chain, consist of a flexible

set of dynamically configurable components, and provide operation management functions, as well as strategic, analytical, and decision support functions. Incompatible hardware and software among partner companies creates a great barrier to IOS by inhibiting seamless communication. Technologies aimed at overcoming compatibility problems include component engineering, middleware, such as CORBA (Common Object Request Broker Applications) and Enterprise JavaBeans, along with platform independent communication protocols such as HTML, XML/XBRL, and other concepts supporting the semantic web. Various platform independent communication technologies, along with middleware technologies, foster interaction among different information and communication technology (ICT) platforms.

A necessary precondition to developing IOS is the need for an integrated ICT infrastructure internal to the partner companies (Siau and Tian 2004). When beginning an IOS venture, it is important that all partners have mature, standardized, and flexible IT infrastructures on which to integrate across company boundaries. Lewis and Byrd (2003) urge companies to address deficiencies in their internal IT infrastructure before business process reengineering or IOS initiatives. Broadbent et al. (1999) also find support for leveraging the information technology infrastructure to achieve successful business process reengineering. Measures developed by Lewis and Byrd (2003) provide an initial means for evaluating a company's information technology infrastructure as a precursor to embarking on business process redesign in support of IOS. In order to address IOS needs, the ERP development lifecycle must expand to address cross-organizational planning and coordinated implementation on many levels. An extended ERP implementation lifecycle model includes inter-organizational collaboration before and after the internal ERP implementation for each collaborating company (Vathanophas 2007). Adapting the ERP implementation framework of Parr and Shanks (2000), Vathanophas (2007) outlines an IOS ERP implementation process starting with joint customer needs collection and organizational assessments in the pre-implementation stage. Building on a trading partner's internal ERP implementations, inter-organizational collaboration continues with joint efforts to integrate the needed systems such as SCM, CRM, and ICTs.

A more revolutionary, rather than evolutionary, approach to ERP systems can be found in the REA ontology (McCarthy 1982; Geerts and McCarthy 2002; Hruby 2006). The REA ontology has its basis in the accounting literature. The initial focus was on the resources, events, and agents involved in economic transactions (McCarthy 1982). The ontology has since evolved to provide type-level (Geerts and McCarthy 2003) and policy-level specifications (Geerts and McCarthy 2006). The REA ontology eschews the traditional double-entry accounting approach that is embedded in all the traditional ERP systems. The REA ontology serves as the basis for the Workday ERP system (Workday 2010), a relatively new ERP product providing support for financial, resource, and revenue management. The Workday approach is claimed to address the combined requirements of accounting, risk management, corporate governance, and analytics into a single cohesive integrated system.

Utilizing REA accounting models, abstracted business processes can be defined and utilized as a set of patterns for business application design (Hruby 2006). This approach offers the promise of being flexible enough to adapt to firm-specific needs, as well as providing a solid map of models on which to design software architectures to achieve improved software quality. The REA ontology is now an international standard (ISO 2010). Past critics of the REA ontology stated that determination of its benefits was a market-based decision. Recently, some organizations and standard makers are adopting this ontology. AIS researchers should possess a relative competitive advantage and should examine the relative benefits of emerging REA-based ERP systems compared to traditional ERP systems. ERP systems maintain a wealth of information of value to balanced scorecard management reports. Given that the REA ontology has been extended with balanced scorecard concepts (Church and Smith 2007), there is potential to bridge between ERP

and balanced scorecard using REA concepts. The REA ontology with balanced scorecard extensions was found to support many of the balanced scorecard constructs, but was found lacking in some of the strategic areas of the balanced scorecard. Future research should examine how the ISO standards-based REA ontology supports the balanced scorecard approaches to ERP and other SEM approaches. This should then be compared to the manner in which other currently available ERP systems support balanced scorecards and SEM constructs.

The other area that has recently undergone significant change is how ERP systems are delivered. "Cloud computing" has the potential to radically change the ERP environment. The data and the application are no longer housed on-premise; rather, a vendor provides access to the application (which can be customized to meet the user's needs) and the vendor also hosts the data (securely) somewhere on the Internet. Netsuite (Netsuite 2010) is an example of an ERP vendor that provides these services. Many research questions surround this evolutionary approach to ERP systems. The issue of user acceptance of these systems versus "locally hosted" systems is an intriguing question, along with the issue of ease of integrating with other supply chain partners' ERP systems. There are also many questions related to the ERP selection process and whether it differs from traditional ERP vendor selection issues. If a company is going to migrate to a cloud-computing ERP environment, do the business risks change? What is the impact on auditing the cloud-based ERP system? This has the potential to be a very rich research area.

Just as prior ERP research focused on reducing barriers between business functions and across organizations within the firm, IOS research is naturally evolving to address ERP systems' reach beyond the individual organization or firm. Seeking seamless ICT integration among partners in the supply chain, IOS research will continue to address existing ERP themes, but broaden the scope to cross-organizational and corporate boundaries.

The research into inter-organizational benefits of ERP systems is in its infancy. There is limited research and a significant need for more. Given the extensive sociological impacts of ERP, there is significant risk of negative inter-organizational sociological impacts of ERP to be overcome. For example, what is the full impact of workarounds when not just one but two ERP systems are subverted and cooperative inter-organizational business processes are no longer followed? These inter-organizational value chain integration efforts through ERP raise fundamental research questions. First, are inter-organizational systems facilitated or complicated by ERP systems—especially when organizations are utilizing different ERP packages? What factors lead to successful inter-organizational cooperation, i.e., is success more dependent on synergetic goals, managerial capabilities, or on technological facilitators such as ERP? How should we measure ERP costs and benefits across the inter-organizational value chain? Beyond ERP technology support, are there other complementarities among other factors (such as inter-organizational culture, operations/processes, and other technologies) that serve as key enablers of inter-organizational firm partnership and realization of market benefits? Is it possible to isolate the benefits of ERP systems if they are intertwined with other processes and/or systems?

IV. ERP ECONOMIC IMPACT

Numerous studies have examined whether economic value has been associated with an ERP implementation. Some studies have focused on announcements of planned ERP system implementations, while others have focused on post-implementation results. Besides looking to the financial markets and reported financial results, a number of studies have utilized other techniques to gain insight into the economic benefits associated with ERP systems, e.g., using a resource-based view of the firm, balanced scorecard, and other approaches. In this section, we review the key outcomes of that research, categorized as either internal evaluation, utilizing accounting and nonfinancial

measures, or external market valuations. While there is not a clear division between these two categories, as some papers examine both internal and external factors, it does provide a way to organize the research.

Internal Evaluation of Firm Benefits

Poston and Grabski (2001) focused on specific accounts within reported financial results of firms that implemented ERP systems. They found no significant improvement associated with residual income or the ratio of selling, general, and administrative expenses in each of the three years following the implementation of the ERP system. They did report a significant improvement in firm performance resulting from the decrease in the ratio of cost of goods sold to revenues only in the third year after the ERP system was implemented. They also found a significant reduction in the ratio of employees to revenues for each of the three years examined following the ERP implementation. Building upon Poston and Grabski (2001), Hunton et al. (2003) examined both the impact of ERP adoption on firm performance and also market reaction to ERP implementation announcements. Their results were consistent with Poston and Grabski (2001). They found that return on assets (ROA), return on investment (ROI), and asset turnover (ATO) were significantly better over a three-year period for adopters as compared to nonadopters. They reported that the significant differences were a result of the decrease in financial performance of nonadopters while it held steady for adopters. Interestingly, they also found a significant interaction between firm size and financial health for ERP adopters. Specifically, a positive (negative) relationship between financial health and performance was found for small (large) firms. They speculated that ERP adoption helps firms gain a competitive advantage over nonadopters.

A different approach was employed by Chand et al. (2005). They used a balanced scorecard for valuing the strategic contributions of an ERP system. The study was based upon a successful SAP implementation. They were able to demonstrate that the ERP system did impact the business objectives of the firm, and they presented an innovative framework for valuing the strategic impacts of ERP systems.

Building on the Poston and Grabski (2001) study on firm performance of ERP implementations from 1993 to 1997, an updated investigation of more recent firm performance would be helpful to determine if the value of ERP meets earlier predictions to reduce costs by improving efficiencies through computerization and enhance decision-making by individual access to enterprise-wide information. Both of these effects were predicted to improve firm performance. The Poston and Grabski (2001) study found no significant improvements in firm performance ratios except for three years lagged improvements in cost of goods sold scaled by revenues. A new investigation to reassess possible benefits is needed, which could also further clarify the myriad of factors affecting the ERP and firm performance relationship. A slightly different perspective of the economic value of the ERP system would involve a comparison of organizations that employed open-source ERP systems relative to those that used traditional vendors with self-hosting. This is related to the investigation needed into the economic and practical impacts of open-source ERP—how many firms and what types of firms (size, industry, functionality) adopt and rely on open-source ERP solutions? What are the actual costs of open-source ERP initial investments, ongoing maintenance costs, and resulting value to the firm when compared with vendor-supported ERPs? What are the characteristics of firms that will benefit from open-source (and cloud-computing) ERP solutions?

Existing research on inter-organizational relationships utilizing business process standards has identified differences between dominant and nondominant firms in terms of three mechanisms—relational, influence, and inertial (Bala and Venkatesh 2007). It would be interesting to determine whether differences affecting business process standards adoption also extend into adoption and use of ERPs within inter-organizational relationships. Further investigation is warranted into the

role of ERP as a technological competency and instantiation of business processes to determine ERP's influence on these relationships. In cases of inter-organizational cooperation, to whom do the economic benefits occur—do they occur equally or differ based on technological sophistication of, or power welded by, one of the trading partner over the other?

External Evaluation of Firm Benefits

Research in this area initially examined whether there was any market reaction to announcements of planned ERP implementations. Hayes et al. (2001) did find an overall positive reaction to initial ERP announcements. The reaction was found to be most positive for small/healthy firms, and that the market response to large ERP vendors is significantly more positive than to smaller ERP vendors. Research found that among United States-based manufacturing firms, larger companies reported improvements in financial measures, whereas smaller companies reported better performance in manufacturing and logistics (Mabert et al. 2003). Roztocki and Weistroffer (2008) examined market reaction to both ERP and enterprise application integration announcements across different markets (bull and bear) and firm financial health. Consistent with previously reported results, financial markets differentiate among technologies in which companies invest to integrate their information systems. Further, technology maturity, financial health of the investing company, and stock market conditions are important factors influencing stock market reaction. Hendricks et al. (2007) expanded this line of research by also examining the effect of investments in Supply Chain Management (SCM) and Customer Relationship Management (CRM) systems, in addition to ERP systems, on a firm's long-term stock price performance and profitability measures. Regarding ERP systems, some evidence of improvements in profitability were obtained, but not in stock returns. Consistent with the first mover literature, the results for improvements in profitability are stronger in the case of early adopters of ERP systems. SCM system adopters generally experienced positive stock returns, as well as improvements in profitability. No evidence of improvements in stock returns or profitability was found for CRM implementations.

Rather than focusing only on implementation announcements, Nicolaou and Bhattacharya (2006) investigated the effects of post-implementation changes on firm performance, while a different approach to understanding firm disclosure behavior was taken by Mauldin and Richtermeyer (2004), who examined financial statement disclosure practices among firms that were implementing ERP systems.

The basic findings of this stream of research are that firms implementing ERP systems are able to obtain benefits, but these first accrue after a period of operation, most often two to three years after implementation (Hitt et al. 2002). Further, firms which do not implement ERP systems find themselves in a relatively worse financial position. It seems as if the advantages obtained through the implementation of ERP systems are short-lived; they are competed away (Hitt and Brynjolfsson 1996) and the consumer is the ultimate beneficiary. Regarding market returns, the market sees through "normal" maintenance of ERP systems and does not provide additional rewards. However, if there is the opportunity for competitive advantage, such as in the case of early ERP system adopters or SCM system adopters, those firms experience positive stock returns. This type of result is consistent with the early research on announcements of IT investments (Dos Santos et al. 1993). Finally, firms that are proactive and initiate early enhancements to their ERP systems enjoy superior performance. Some key papers on economic impacts are identified in Table 4 of the online resources. Given the consistency of findings in this area, we do not have any pressing new research questions for this area. Any future research would need to address truly unique questions and issues in order to provide a significant contribution to the literature.

V. CONCLUSION

Shanks et al. (2003) described the first ERP wave as the acquisition, configuration, and implementation of the ERP system, while the second wave focuses on making continuous im-

provements and maximizing the benefits from the ERP system. Implementation issues no longer need to be the primary concern of researchers. Rather, the focus should be on ERP's overall firm benefits and the ongoing effective utilization of the ERP system. In their study of the "second wave" of ERP systems, Rikhardsson and Kræmmergaard (2006) report that the ERP system can facilitate change in the basic assumptions (e.g., predominant language, value, culture, etc.) within the organization, and also the specific processes, rules, and procedures that are followed. The net result is that organizational outcomes are not determined by the ERP implementation; rather, outcomes are based upon the subsequent utilization of the ERP system (Rikhardsson and Kræmmergaard 2006). An ERP system interacts with the actors of the organization; the outcome of the interaction is only partially predictable and, hence, the perspective that an ERP system is a deterministic technology is not valid (Boudreau and Robey 2005). The changes resulting from the ERP implementation reported by the organizations studied were seldom fully predicted in the short or in the long run.

What We Know

What do we know about ERP systems? First, implementing an ERP system is costly and time-consuming. While many lists of critical success factors have been generated, further research is needed into the appropriate mix and application of these factors. Based upon the reviewed research, much remains to be learned and current guidance is best left to an alchemist to discern. Second, ERP systems can provide competitive advantage, but this is short-lived. Archival studies have shown that firms which do not implement an enterprise system perform relatively worse than those which implemented an ERP. Firms that have successfully implemented an ERP system compete away the gains obtained from these systems, and the customers are the ultimate beneficiaries of the implementation. Third, culture matters. Culture is both internal to the organization (and to individual locations), and is external to the organization in the form of the culture and traditions of the countries in which the organization operates. Fourth, when people interact with technology and processes, outcomes are not predictable or easily determined. The introduction of an ERP system into the organization provides new conditions with a myriad of impacts. ERP influences the behaviors of people, which in turn changes how systems are used, or not used in the case of user resistance and workarounds. Individuals have adapted ERP systems to fit their own needs, regardless of the intention of top management or IT designers when the system was first implemented. This means that communication, change management, education, and user involvement are critical for the successful use of the ERP system, and to successfully guide ERP adaptation and evolution in later phases. Fifth, ERP systems continue to evolve. They are reconfigured, updated, and extended. Extensions of all types may be considered and added to the integrated ERP core system. Common extensions take the form of business intelligence (BI) applications, interorganizational value-chain integration enhancements, or focus on security, auditability, and reporting, among other functions.

What We Need—Theory

Much has been written about ERP implementation and use. Unfortunately, much of the research (such as the large number of papers on critical success factors) has been survey-based, without strong underlying theory. In many topics reviewed here, a similar limitation exists—the lack of a strong theoretical base. As such, unless a research paper is following a design science methodology (Hevner et al. 2004) or grounded theory building approach, a strong theoretical development and a rigorous research design need to be utilized. There are many different theories that could be explored to enhance ERP research insights, depending on the type of research.

Contingency theory could be used to advance the concept of ERP fit to the organization needs. The congruence or fit of an AIS with the firm's requirements was found to influence beliefs about

system effectiveness. Empirical research supports the notion that the fit between the accounting system design and the contingency factors resulted in a more successful system (Nicolaou 2000). This theoretical approach could be fruitful if applied directly to the ERP context to investigate various configuration choices made within firms.

Social capital theory could be employed in studies examining the relationship between consultants and users, between vendors and users, between top management and lower levels of management, and between units which are co-located versus geographically dispersed. Social capital theory has been developed to explain social relationships developed over time and provide the context for social interactions within and between organizations (King and Burgess 2008). If social capital increases, then improved social outcomes will exist, such as improved collaboration and knowledge sharing. The use of social capital theory can help explain the relationship among various individuals involved in ERP system implementation, use, and enhancement. It could also help explain why some organizational entities have difficulty accepting and using ERP systems while others do not.

Social exchange theory attempts to explain what motivates individuals to certain behaviors (Kelley and Thibaut 1978). Interpersonal interactions are examined from a cost-benefit perspective. Unlike economic exchanges, social exchanges are not governed by explicit rules. The underlying assumption is that individuals participate only when the benefits exceed the costs of participation. The benefits, however, can be difficult to quantify. For example, how is respect, friendship, honor, or any other intangible factor quantified (Gefen and Ridings 2002; King and Burgess 2008)? Social exchange theory helped explain different outcomes in two CRM implementations (Gefen and Ridings 2002). In one organization, there were fast and constructive reactions to requests for patches and modifications, whereas the other was characterized as slow and less helpful. The results support that, based on these social exchanges, the users would perceive that the system developers cared, affecting users to be supportive and use the system. There are many similarities between CRM and ERP projects, indicating that social exchange theory could be valuable to help explain differential behavior in the adoption of ERP systems.

There are a number of other theories useful to understanding how individuals react to ERP systems and how they ultimately use (disregard) them. One approach is to look at the social world as a network of stories (Abbott 1992). Stories consist of sequences of events. Within the setting of an ERP system adoption and use, an individual may have the choice to use the new ERP system or continue to use other types of reports to manage. The sequences of events, rather than variables, would be examined from a network-of-stories perspective. Ramiller and Pentland (2009) argue that stories are needed for individuals to understand problems and make decisions, and that stories need to include specific events tied to specific contexts. Another approach is to use actor network theory (ANT), a sociological theory that has been applied in critical evaluations of ERP implementation cases (Dechow and Mouritsen 2005; Elbanna 2007). Actor network theory treats social relations, organizations, and power as network effects. A basic tenet of ANT is the heterogeneous network, a network consisting of dissimilar objects in which all of the objects (e.g., individuals, organizations, things, hardware, software, etc.) are actors (Law 1992). Findings reveal that ERPs can create a highly political and largely disintegrated social context for the ERP implementation (Elbanna 2007). ANT analysis supports the view that management control in an ERP environment is no longer the property of the accounting function, but becomes a collective organizational responsibility (Dechow and Mouritsen 2005). The later ANT analysis supports the view that control cannot be studied apart from technology and context. This theory has also been used to examine an ERP implementation in an academic setting (Scott and Wagner 2003). Future researchers may want to consider utilizing this and other sociological and behavioral theories. Also,

diffusion of innovation theory seeks to explain how individuals adopt new technological innovations and how these innovations are spread throughout an organization (Moore and Benbasat 1991) and could be used in the context of ERP systems.

Two other significant needs in ERP research ought to be mentioned. One relates to the extensions in ERP systems, which is best addressed through a design science approach (Mauldin and Ruchala 1999). That is, how do we develop and evaluate a better "ERP artifact" and how do we extend the "ERP artifact"? The other research need relates to the interaction of individuals with the ERP artifact, and here a social science approach is applicable. The question is first, how do we explain individuals' interaction with the ERP artifact, and second, how do we leverage this interaction to allow the most effective and efficient use of the ERP artifact so that organizational objectives can be accomplished?

What We Need—Levels of Analysis

The diversity of research on ERP systems reflects a number of different levels of analysis, offering interesting new perspectives with the potential to uncover insights into the complexities of the ERP systems artifact and the ERP organizational context. The broad reach and varied impacts of enterprise systems can be studied at various granularities of subject matter, from individual user impacts to various organizational levels within and, increasingly, among groups of organizations. In ERP literature, the complexity of levels of analysis is evident, adding to the levels commonly identified (Glass et al. 2009) by including levels of analysis for projects, business processes or organizational routines (Pentland and Feldman 2005), applications (business functions such as supply chain, customer relations, business intelligence, etc.) and industry types. The business process level of analysis addresses a cross-functional or inter-organizational analysis of a single business process, such as the supply chain process (Hunton et al. 2003; Wieder et al. 2006), order fulfillment process (Cotteleer and Bendoly 2006), process integration (Park and Kusiak 2005), or business process management (Al-Mudimigh 2007). The project level of analysis is used to refer to incremental ERP system expansion projects which add ERP modules, integrate ERP with other systems, or introduce new technical capabilities into the ERP system, such as XBRL, data warehouse, or internal controls extensions (Light et al. 2001; Chou et al. 2005; Sammon and Adam 2005; Dery et al. 2006b; Bose et al. 2008). The industry category contains studies seeking to reveal differentiation by industry, establish causal relations unique to a given industry, or confirm commonalities in ERP experiences that hold across multiple industries (Muscatello et al. 2003; Somers and Nelson 2003; Baray et al. 2008; Shahneel et al. 2008). This category is not meant to merely reflect the subject pool of the study, but rather to include studies specifically investigating a theorized difference (or similarity) between industries. Inter-organizational ERP research is a growing area which should therefore be the focus of increased research (Broadbent et al. 1999; Siau and Tian 2004; Vathanophas 2007). Research taking a project, functional business process, or application approach is a somewhat novel aspect of ERP systems research, which expands the traditional choices of analysis from those typically found in information systems and management literature.

Where We Are Going

It is evident that ERP system adoption is pervasive and becoming more firmly entrenched. Meanwhile, the technology and its extensions constantly evolve, with corporate and regulatory entities demanding that ERP provide even greater value to organizations. We note in this review that ERP research has reached a relatively mature stage in some areas, including CSF (macro level) and economic impacts. In general, to offer value, ERP research in these areas should have more underlying theory, increased rigor, new approaches, and be viewed in a more critical manner than in the past. Does the research question really offer new insights missing from prior research?

Additionally, does this research address a previously unaddressed but interesting research question, such as one that challenges existing assumptions or beliefs (and is not another survey on critical success factors in implementing ERP systems)? Does the research have a strong theoretical basis and clearly defined level of analysis?

In this review, we note that ERP extensions and inter-organizational systems call out for research with a greater emphasis on addressing the full lifespan of ERP systems, as well as their place in the broader value chain. There are also calls for increased research on ERP systems' impact on how work is managed and organized, how sociological factors from the individual to the institutional level interact with ERP installations, and what are the implications on power relations and management control (Dery et al. 2006a).

ERP is now pervasive in large firms and has a quickly growing presence in small and mid-sized enterprises (SMEs). ERP adoption in industry continues to evolve and expand. Installations are becoming increasingly complex through upgrades, expanded functionality, tighter integration with legacy systems, extensions by integrating new applications, and increased inter-organizational reach. ERP systems are now available as Software as a Service (SaaS), and research is needed to address the implementation, use, and risks and controls in this new environment. Does this different method of providing an ERP system result in different organizational effects than traditional ERP implementations?

In highlighting future research, this review has identified the following major research areas that require attention (not necessarily in order of importance):

1. Understanding the mix and interaction of critical success factors in different types of implementations, particularly in ERP upgrades and conversions to different ERP systems.
2. The individual, team, and organizational heuristics that result in successful ERP implementation and use.
3. Research into the inter-organizational benefits of ERP systems.
4. Research into benefits arising from the use and integration of DSS/BI/Business Analytics/SEM software with ERP systems.
5. The potential risks in using ERP systems and implications for security, audit, and control.
6. The role of ERP systems in the implementation of IFRS and the use of XBRL.
7. The type of theories that can be used to understand the relationships between ERP systems and organizational culture and organizational change.

Besides following the research directions presented here, further research ideas many be devised based on the background provided by this review. A useful instructional approach to identifying further ERP research topics is found in Lee's (2000) editorial, where existing journal article topics are reframed into potential ERP research topics. Some research streams have published sources for ERP research ideas, including behavioral research directions in ERP (Arnold 2006) and operations research topics (Jacobs and Bendoly 2003).

This review highlights the existing breadth and diversity of extant ERP research, but also points the way toward even more extensive and diverse areas of investigation related to ERP systems. The overall scope of ERP-related literature is already quite broad. As this area moves forward, ERP research needs greater focus on theoretical support and theory development to explain findings, exploration of new levels of analysis (e.g., project, group, or sub-unit, etc.), and longer-term investigations into the mature stages of post-implementation use, upgrades, and the co-evolution of ERP systems, organizational structures, business processes, and individual job definitions. It is hoped that this review has provided not only an overview to the variety of topics and approaches in ERP research, but also serves as a preliminary step toward organizing the growing volume of enterprise systems-related research.

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