WORK FORMALIZATION, DYNAMIC CAPABILITIES, AND BUSINESS PERFORMANCE IN THE CONTEXT OF ENTERPRISE RESOURCE PLANNING

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ABSTRACT

WORK FORMALIZATION, DYNAMIC CAPABILITIES, AND BUSINESS PERFORMANCE IN THE CONTEXT OF ENTERPRISE RESOURCE PLANNING

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Enterprise Resource Planning (ERP) investments are believed to produce operational improvements and sustained competitive advantage only when adopters develop effective capabilities. There is a lack of knowledge about the mechanisms through which ERP-enabled capabilities are generated. This study is an attempt to define a pathway through which ERP may lead to higher process and business performance by examining work formalization as a contingency factor boosting organizational enablers of dynamic capabilities, which in turn, enhance business performance in the context of ERP implementations. ERP pathways to dynamic capabilities and business performance are approached using the distinction between the enabling and disabling forms of work formalization as characteristics of the conditions under which ERP is implemented. The proposed framework combines both the contingency theory perspective and the resource-based perspective in an attempt to understand the moderating effect of the type of work formalization.

A questionnaire was used to ask 500 managers at companies using ERP systems matched with a control group based on industry and size to rate their organization's current work formalization, process efficiency, process flexibility, and business performance. Based on the results of this study, the enabling aspect of work formalization

appears to significantly boost process performance and process flexibility for ERP adopters. The boosted process flexibility seems to in turn significantly enhance business performance in the context of ERP implementations. Process efficiency, however, was not found to significantly lead to higher business performance.

Chapter 1: Introduction

Information Technology (IT) systems have become the primary asset for supporting all processes through which organizations react to changes in their internal and external environments (Mendelson, 2000). However, empirical evidence supporting the view that investments in IT systems enhance firm performance has been elusive (Chan, 2000). The inconsistencies observed among various empirical studies have not only been attributed to variation in methods and measures used in the analyses (Hitt & Brynjolfsson, 1996) but also to differences in their theoretical perspectives.

The academic research focusing on the relationship between Enterprise Resource Planning (ERP) as large scale enterprise-wide IT systems and firm performance produced mixed findings. ERP systems have been viewed by a number of researchers as effective IT investments having the potential to optimize the contribution of profit maximization factors in profit-seeking organizations (Blocker *et al.,* 2002). However, large performance differences are often observed among ERP adopters (Mabert *et al.,* 2003; Umble *et al.,* 2003) and the mechanisms through which ERP systems impact productivity and hence profitability, appear to remain least understood. It is also unclear whether the eventual impact of these systems on business performance may be directly explained by the systems' technological features or more by the IT-enabled capabilities that the adopter develop during the implementation process. The fact that the implementation of similar ERP systems has led to different levels of operational and financial performance seems to suggest that factors influencing the success of these implementations and ultimately business performance lie outside the ERP technological features (Masini, 2003).

1.1. Statement of the Problem

The specific problem addressed in this study is the lack of robust theoretical understanding and empirical research regarding the non-technological factors moderating the impact of ERP implementation on operational enablers of dynamic capabilities and business performance. Studies using the resource-based perspective (RBV) have long examined the benefits of ERP implementations by investigating their impact on organizational capabilities (Bharadwaj, 2000; Clemons *et al.,* 1991; Duliba *et al.,* 2001; Mata *et al.,* 1995; Ross *et al.,* 1996). However, there seem to be a lack of knowledge about the mechanisms by which these capabilities are developed and how the impacts of ERP-generated capabilities on business performance vary with different implementation strategies and various organizational settings (Bendoly, 2004). The contingency perspective explains the observed variations of IT investments impact on business performance using the characteristics of the environmental context within which each organization operates (Brynjolfsson *et al.,* 1994; Ein-Dor *et al.,* 1978; Gattiker *et al.,* 2005; Harris *et al.,* 1991; Masini, 2003; Pavri *et al.,* 1995). However, contingency studies are focused on the relationships between IT investments and business performance, without necessarily considering the impact and role of organizational capabilities. Therefore, there is a need for studies exploring the impact of non-technological contingent factors on the relationship between ERP implementation, organizational capabilities, and business performance.

1.2. Purpose of the Study

This study integrates some of the findings of contingency theories and resource-based view theories regarding the benefits of IT investments to further explore the non-technological factors moderating the relationship between ERP implementation and process and business performance. A contingency approach suggests that some non-technological organizational attributes are capable of interfering with the organization adaptation process in the context of large scale IT investments, such as ERP, and are therefore believed to affect business performance (Masini, 2003). Recent contingency studies have identified work formalization in the form of bureaucracy as an organizational attribute that can potentially interfere with the organizational adaptation process (Bigley *et al.,* 2001).

This research will integrate some of the findings of contingency theories and RBV theories regarding the benefits of ERP investments in terms of operational enablers of dynamic capabilities and business performance in order to examine the moderating effects of work formalization.

1.3. Definition of terms

Work formalization is defined as an organizational attribute characterizing the organizational structure and rigidity, and the prevailing knowledge codification mechanisms used in an organization (Bigley *et al.,* 2001; Hoy, 2003). Specifically, the distinction between "enabling" vs. "coercive" bureaucracy is used to identify the two basic forms of work formalization.

Coercive bureaucracies are those using hierarchy and excessive task formalization to impose conformity to existing procedures and routines. Organizations with a coercive form of work formalization use rules and procedures to punish employees, obstruct innovation, to minimize the need for professional judgment, and undermine employees (Sweetland, 2001; McGuigan, 2005). The enabling attitude of non-coercive bureaucracies, however, stems on their focus to use task formalization and conformity to empower employees and predispose them to innovate (Arches, 1991). This type of work formalization is believed to enable authentic communication between managers and employees, enable employees to do their job better, and guide employees to solutions rather than road blocks (Sweetland, 2001; McGuigan, 2005).

Individuals -- a building block of the organization as a structured social system -- need to modify their working habits to adapt to the new procedures dictated by the ERP best practices. By interfering with this adaptation process, work formalization may impact the relationship between ERP implementation, and process and business performance.

Operational enablers of dynamic capabilities are defined as the firm's ability to systematically generate and modify its operational routines to develop its capacity to renew competences and adapt to the rapidly changing environment (Masini, 2003; Teece, 1997). Specifically, two aspects of these operational enablers of dynamic capabilities are examined: process efficiency and process flexibility.

Process efficiency and process flexibility are viewed as two critical aspects of an organization's operational enablers of dynamic capabilities. Process efficiency refers to an organization's ability to minimize the amount of time and resources required to

execute tasks. Process efficiency is also believed to be linked the firm's capability to integrate processes across functional areas in order to improve workflow, standardize business practices, improve order management, and provide accurate accounting of inventory and better supply chain management. Process flexibility on the other hand is usually linked to the firm's ability to adapt its existing business processes to the changing environment. Process flexibility usually refers to the organization's ability to reallocate resources and modify processes to adapt to unexpected events (Masini, 2003; Swanson, 1994; Teece, 1997).

As operational enablers of dynamic capabilities, both process efficiency and process flexibility are theorized in this study to further enhance business performance. Business performance is defined using an organization's perceived profitability and sales growth compared to three benchmarks: performance of the most direct competitor, performance in previous years, and expectations of leadership. Perceived performance will be used as a proxy for actual performance. This stand has been supported by previous research (Anderson *et al.,* 1995; Brown *et al.,* 2000; Dean & Snell, 1996; Ketokivi *et al.,* 2004; Vickery *et al.,* 1993).

1.4. The Enterprise Resource Planning Context

The concept of Enterprise Systems (ES) emerged decades ago when companies started automating various labor-intensive back-office processes (O'Leary, 2000). These systems evolved tremendously as developers and managers begun looking for ways to systematically integrate technology-assisted business processes. Systems such as Manufacturing Resource Planning (MRP) and MRPII were designed to assist managers in manufacturing companies plan their activities and track materials through their plants

based on forecasting models and actual customer orders. MRP systems set the floor for the emergence of ERP systems, which initially included all MRP features but also supported post-sales and marketing processes (Jacobs & Whybark, 2000). ERP systems developed quickly to represent a true revolution in the world of technology-assisted business processes. These systems are usually organized around "best practices" or "reference models" that define optimal process configuration and resource allocation schemes. The implementation of ERP systems may therefore require a major re-engineering of the firm business process (Keller *et al.,* 1998).

But what does the term ERP precisely means? A review of the literature shows a certain degree of confusion as to the exact meaning of the term. A number of studies (Sarkis *et al.,* 2000; Van Everdingen *et al.,* 2000; Poston *et al.,* 2001; Soh *et al.,* 2000) used ERP as a management concept and ERP systems interchangeably. It is important to understand the difference between the two terms to be able to adequately define the ERP context, which is the main focus of this study.

On the one hand, ERP systems can be defined as software packages managing information flows within and across complex organizations. They are designed to process complex transactions and allow integrated real-time planning, production, and customer service (O'Leary, 2000). These large-scale systems integrate different application programs in most organizational functions such as accounting, finance, human resources, and manufacturing (Jacobs & Whybark, 2000). According to Davenport (2000), ERP systems possess three common characteristics: real-time capture of data, integration of data into a single database, and online delivery of relevant data to decision makers at different levels. The primary benefits of ERP systems are believed to come essentially

from their unique capability to efficiently process and document complex transactions thus allowing for potential cost savings (Jacobs, 2003).

On the other hand, the concept of ERP is usually tied to the actual capability supported by ERP systems. Mabert *et al.* (2000) link the concept of ERP to the firm's capability to use enterprise systems to integrate processes across functional areas in order to improve workflow, standardize business practices, improve order management, and provide accurate accounting of inventory and better supply chain management. Ng *et al.* (1999) share the same basic definition of the ERP concept but add the firm's ability to use enterprise systems to achieve future business process flexibility as a key capability defining the ERP concept.

ERP systems are, therefore, viewed as the technical infrastructure or the technical manifestation required to support and to maintain the ERP concept, which is essentially tied to firm's capabilities of process efficiency and process flexibility. Figure 1 is a simplified depiction of ERP systems in their support role to the ERP concept. The figure uses Davenport's functional definition of the typical anatomy of ERP systems and its basic systemic benefits (Davenport, 1998, 2000, 2003) to visually illustrate an abstract link between ERP systems and ERP concept. It also complements Davenport's definitions with other definitions discussed earlier in this chapter (Jacobs, 2003; Jacobs & Whybark, 2000; Mabert *et al.*, 2000; Ng *et al.,* 1999; O'Leary, 2000). ERP systems are depicted to represent the technical infrastructure used by organizations to automate the business processes related to financials, inventory and supply, services, reporting, manufacturing, human resources, and sales and delivery. ERP systems are believed to allow real capture of data and data integration and to ensure data accuracy and the ability

for online deliver of data. These system benefits help organizations with ERP efforts, i.e., integration, standardization, and adaptability, which are believed to contribute to process efficiency and process flexibility.

ERP concept is therefore portrayed based on the previously discussed ERP concept definitions provided by Mabert *et al.* (2000) and Ng *et al.* (1999). Process efficiency is the firm's capability to integrate processes across functional areas in order to improve workflow, standardize business practices, improve order management, and provide accurate accounting of inventory and better supply chain management. Process flexibility is the firm's ability to adapt its existing business processes to the changing environment. Process efficiency and flexibility are typical operational enablers of dynamic capabilities, which are discussed later in this study.

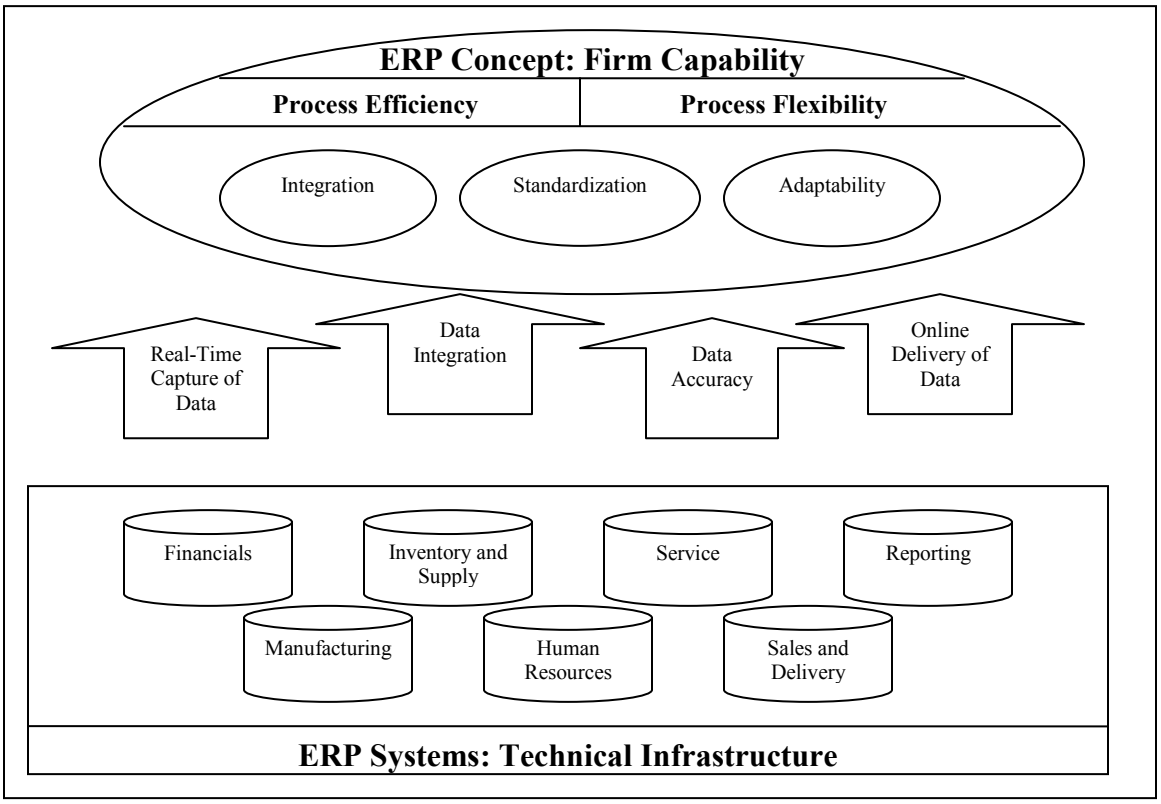


Figure 1: Enterprise Resource Planning Context
Source: Davenport, 1998, 2000, 2003; Jacobs, 2003; Jacobs & Whybark, 2000; Mabert et al. 2000; Ng et al., 1999; O'Leary, 2000

1.5. Research Questions

This study aims at addressing the lack of robust theoretical understanding and empirical research regarding the non-technological factors moderating the impact of ERP on operational enablers of dynamic capabilities and business performance. The general question that will be addressed here is:

Is the relationship between ERP implementation and business performance moderated by the form of work formalization?

Two additional research questions will be investigated to further explore the non-technological factors moderating the impact of ERP implementations on process and business performance. The first question rests up on the logic of contingency perspective to examine the moderating effect of the form of work formalization on the relationship between ERP implementation, and process flexibility and process efficiency as operational enablers of dynamic capabilities. The first question of interest is:

Is the impact of ERP implementation on operational enablers of dynamic capabilities moderated by the form of work formalization?

The second research question is based on the RBV logic and investigates the mediating effect of operational enablers of dynamic capabilities, i.e., process flexibility and process efficiency, on the relationship between ERP implementation and business performance. The second question of interest is:

Is the impact of ERP implementation on business performance mediated by operational enablers of dynamic capabilities?

This study examines both inter-related research questions concurrently; thus, it synergizes the two well-established theoretical perspectives and leverages them to

improve our current understanding of the mechanisms through which ERP implementation influences business performance.

1.6. Nature of the study

A non-experimental field study utilizing survey research was carried out to address the research questions. This study follows Masini (2003) and Davenport (2004) studies in that it uses a quantitative analysis of information obtained from surveys of managers at organizations with Enterprise Systems. This cross-sectional study uses a questionnaire to collect data from a sample of US firms to tackle the research questions and empirically examine the hypotheses. The sample includes firms that had recently adopted an ERP system as well as those not using an ERP system.

1.7. Significance of the study

This dissertation on ERP will add substance to the work already conducted by some notable authors (Davenport, 1998; Gattiker *et al.,* 2005; Mabert *et al.,* 2000; Mabert *et al.,* 2003; Markus *et al.,* 2000; Masini, 2003; McAfee, 2002; Poston *et al.,* 2001; Ross *et al.,* 2000; Shin, 1999). The implementation of similar ERP systems has been shown to lead to different levels of operational and financial performance. Contingency studies are focused on the relationships between IT investments and business performance, without necessarily considering the impact and role of organizational capabilities. RBV studies have not always investigated the mechanisms through which ERP-enabled capabilities are generated (Masini, 2003). This study will attempt to define a pathway through which ERP may lead to higher process and business performance by examining work

formalization as a contingency factor boosting organizational enablers of dynamic capabilities, which in turn, enhance business performance in the context of ERP implementations.

Although the studies on ERP systems conducted by the authors cited in the previous paragraph are useful, they remain exploratory with very limited managerial and practical implications. The proposed study will attempt to provide ERP adopters and software vendors with a better understanding of how non-technological factors, i.e., the form of work formalization, may lead to improved post-implementation ERP-enabled dynamic capabilities, which in turn, enhance business performance. This study may demonstrate that the mere implementation of ERP systems without creating the appropriate conditions to develop ERP-generated capabilities does not necessarily enhance performance. The findings of this study may also shed some light on the importance of some aspects of organizational reengineering.

1.8. Organization of the Study

The remainder of the study includes a literature review in Chapter two examining prior research that has been carried out in the areas of ERP. The chapter attempts to link and integrate some of the findings of contingency and RBV theories to develop a theoretical model that tackles the research questions examined by this study.

Chapter three describes the methodological approach used in this study including: a description of the survey research design, the sampling design, the planned approach to instrumentation to collect data, and finally the chosen methodology on which to conduct analysis of the data. Thus, further chapters describe the elements and components of the actual study, with an eye to conclusions that may form the foundation for future

recommendations and the possible creation of a theory to be examined in further research.

Chapter four presents, in a step-by-step approach, the survey research design. The choice of design is related to the literature review assumptions underlying the original research questions. The process of conducting the survey protocol, data collection and inhibitors encountered, a descriptive range of qualitative and quantitative methods employed in examining and triangulating the content obtained in combined outcomes are discussed.

Chapter five focuses on generalized findings, limitations, and ramifications for both ERP adopters and ERP vendors. A prescriptive approach to dealing with work formalization during ERP implementations is presented.

Chapter 2: Literature Review

Evidence supporting the view that investments in IT systems enhance firm performance has been elusive (Chan, 2000). The inconsistencies observed among various studies investigating the relationship between IT investments and firm performance have been attributed to variation in methods and measures used in the analyses but also to differences between the IT systems considered in each study (Hitt *et al.,* 1996). This study will focus on Enterprise Resource Planning or ERP systems, which have become widely used and as such are considered to be a representative category of current enterprise information systems.

Both RBV and Contingency perspectives have been used by researchers to examine the impact of ERP implementations on organizational capabilities and business performance. This study integrates some of the findings of both perspectives in an attempt to explore the conditions under which organizational capabilities are developed following an ERP implementation and how the impacts of ERP-generated capabilities on business performance vary with different forms of work formalization, which is an organizational attribute believed to interfere with the organizational adaptation process (Bigley *et al.,* 2001).

The proposed literature review will first discuss the theoretical and practical relevance of the ERP context. Then, work formalization's influence on the mechanisms through which ERP generates operational enablers of dynamic capabilities will be examined from both the RBV and Contingency perspectives. Finally, a comprehensive model defining a pathway through which ERP boosts the generation of dynamic capabilities and further enhance business performance will be developed to integrate the

two well-established perspectives and tackle the research questions formulated in the previous chapter.

2.1. Enterprise Resource Planning

The ERP context has recently received special attention from the academic and professional communities. A thorough review of the current literature shows that the ERP context is relevant to both researchers and practitioners from theoretical, empirical, and practical perspectives.

2.1.1. Theoretical Relevance of ERP

Recent research studies seem to indicate that the admittedly misunderstood ERP context is too broad and research should start switching its focus to more controllable contexts, such as Business-to-Business and Customer Relations Management (Jacobs, 2003). However, it is critical to realize that the physical distribution and purchasing infrastructure capabilities supporting these new business practices are in essence tied to the ERP context as they are usually supported by ERP systems. By ignoring the ERP context within which these capabilities develop and flourish, researchers may miss the big picture, possibly leading to the type of inconsistencies responsible for the notorious productivity paradox (Jacobs, 2003). A better understanding of the ERP context has the potential to provide a sound and logically structured framework for studying the linkages between these prominent business practices and organizational performance.

The reported high profile failures of ERP and other enterprise-wide systems implementations have long been feeding anxiety about the actual benefits of such large IT investments. Proponents of the "IT productivity paradox" have been arguing that investments in IT innovations, such as ERP systems, could be ineffective or could

negatively impact performance (Nolan, 1994; Strassmann, 1990; Utpton and McAfee, 1998, etc.). Other researchers such as Roach (1987), Loveman (1994), and Brynjolfson *et al.* (1996) justify the difficulty to explain the failure of investments in information technology to meet expectations by stressing the complexities of examining the contribution of information technology to firm productivity and performance.

Although the theory examining the IT paradox makes the ultimate impact of ERP as an IT innovation on performance appear to be uncertain or unfavorable, well regarded empirical studies have established a link between IT information systems, IT capability and performance. Hitt *et al*. (1996) studied a sample of 367 large firms to assess econometric models of the contribution of information systems to firm-level productivity. Hitt *et al.'s* (1996) study is an attempt to provide new empirical evidence to explain or reject the productivity paradox. The authors use firm-level data based on five annual surveys over the period 1987-1991. The requested identity of participating firm was used to supplement the collected data from various other sources in order to assess multiple econometric models of the contribution of information systems to firm-level productivity.

Hitt *et al.* (1996) found that information systems' spending makes a substantial and significant contribution to firm output. Computer capital and information systems' labor are reported to increase output significantly under various formulations. Some of the models used in their research were used in prior studies but produced different results. The discussion provided by Hitt *et al.* (1996) seems to indicate that the size of firms in their sample, i.e., relatively large "Fortune 500" firms, and the massive build up of information systems capital may be required in order to observe any significant information systems contribution to firm-level productivity. These two requirements are

usually typical characteristics of the ERP context which indicates that ERP systems may have a substantial and significant contribution to firm productivity.

Similar to Hitt *et al.* (1996), Bharadwaj *et al.* (2000) revisited the productivity paradox. They used the RBV of the firm to develop the concept of IT as an organizational capability and examine its impact on firm-level performance. RBV researchers argue that investments in IT can be easily duplicated and therefore it is the unique IT resources and skills created by firms that can impact a firm's performance and provide sustained advantages. The study identified IT infrastructure, human IT skills, and IT-enabled intangibles as the three main IT resources enabling a firm's IT capability. The authors employed the "matched sample comparison group" methodology to assess the effects of superior IT capability on firm performance. The selected sample for this study comprised 56 firms ranked as IT leaders by InformationWeek at least twice during the period 1991 - 1994. A matching set of control firms was drawn from the Compustat database, which was also used to collect data related to firm performance measures for both the treatment and control groups. The study used five profit-based measures scaled by measures of firm size based on sales, assets, and number of employees.

Bharadwaj *et al.* (2000) empirical inquiry showed a significant positive relationship between IT capability and superior firm performance. All profit ratios in each of the four years were significantly higher for IT leaders when compared to the control group. The cost-of-goods to sales ratio was significantly lower for the IT leaders sample in two of the four years. The selling and administrative expenses to sales ratio did not reach the significance level in any of the four years but it was higher for the IT leaders group. Bharadwaj *et al.* (2000) concluded that IT systems might compliment

other firm-level resources to create an IT capability that is not easily imitated or substituted.

The recent increase in the number of studies adopting a systematic approach to examine various aspects of the ERP context has stimulated its theoretical and empirical interest. The high failure risk and costs associated with ERP systems have led decision makers to strive for recommendations based on sound theories and empirical studies (Masini, 2003). Noting that most ERP studies had been anecdotal or still at the exploratory stage, researchers have initiated several attempts to examine this phenomenon using a more systematic approach. Researchers have been developing more and more rigorous statistical frameworks to test the effects ERP systems adoption. More studies have been applying traditional Operations Management and Organizational Research paradigms in the context of ERP using mathematical modeling, simulations, and more comprehensive surveys. These frameworks facilitated the initiation of a much needed empirical examination of the performance implications of ERP.

2.1.2. Practical and Empirical Relevance of ERP

The continuous phenomenal ERP invasion of the corporate world keeps feeding researchers' interest in understanding the ultimate impact of ERP systems. The Aberdeen Group recently published in their 2006 ERP in Manufacturing Benchmark Report the results of a survey exploring ERP strategies and implementation status of over 1,200 companies of all sizes. The survey showed that 80% of large companies with more than $1 million in annual revenue had more than one ERP system in place. Only 9% of companies did not have any ERP systems in place.

Although most empirical studies examining the performance implications of this

phenomenon of great relevance to both researchers and practitioners appear to be still at an embryonic stage with a narrow scope, recent studies have identified some pathways through which enterprise systems (i.e., ERP systems) may lead to higher business performance after the implementation is completed. Table 1 below lists the main benefits cited by recent studies that are theorized to lead to increased organizational performance.

Table 1: Recent Empirical Findings about the Benefits of ERP Systems

ERP Benefits	Authors	Methodology	Sample Size
Overall Benefits			
Improved Perceived Firm Performance	Gattiker *et al.* (2005)	Survey	129
Higher Customer Satisfaction	Markus *et al.* (2000) Davenport (1998)	Case Study Case Study	1 9
Increased Interaction with Stakeholders	Mabert *et al.* (2000) Ross *et al.* (2000)	Survey Interviews	479 15
Enhanced Decision Making	Ross *et al.* (2000)	Interviews	15
Process Benefits			
Faster Task Execution Time	Masini (2003)	Survey	82
Improved Task Efficiency	Gattiker *et al.* (2005)	Survey	129
Faster Process Cycle Time	Markus *et al.* (2000)	Case Study	16
Improved Lead Time	McAfee (2002)	Natural Experiment	1
Improved On-time Delivery	McAfee (2002) Mabert *et al.* (2000)	Natural Experiment Survey	1 479
Improved Order Cycle	Mabert *et al.* (2000) Davenport (1998)	Survey Case Study	479 9
Shorter Financial Close Cycle	Mabert *et al.* (2000)	Survey	479
Enhanced Coordination	Gattiker *et al.* (2005) Shin (1999)	Survey Longitudinal Study	129 232
Ability to Rotate Jobs	Masini (2003)	Survey	82
Financial Benefits			
Lower Labor Costs	Poston *et al.* (2001) Markus *et al.* (2000) Davenport (1998)	Longitudinal Study Case Study Case Study	50 16 9
Lower Coordination Costs	Shin (1999)	Longitudinal Study	232
Lower Operating Costs	Mabert *et al.* (2000) Ross *et al.* (2000)	Survey Interviews	479 15
Decreased Inventory Levels	Mabert *et al.* (2000) Davenport (1998)	Survey Case Study	479 9
Lower Inventory Levels	Markus *et al.* (2000)	Case Study	16
Improved Cash Management	Mabert *et al.* (2000) Davenport (1998)	Survey Case Study	479 9
System Benefits			
Improved Data Quality	Gattiker *et al.* (2005)	Survey	129
Improved Accuracy of Information	Masini (2003)	Survey	82
Improved Response Time	Mabert *et al.* (2000) Davenport (1998)	Survey Case Study	479 9

Poston *et al.* (2001) have established a linkage between ERP systems, better decision-making, and reduced costs. The authors used economic and industrial organization theories to argue that ERP systems should reduce costs by improving efficiencies through computerization and should enhance decision making by providing accurate and timely enterprise-wide information. The literature reviewed by the authors led them to hypothesize that ERP systems might reduce both internal and external coordination costs.

Internal coordination costs involve agency costs and decision information costs (Poston *et al.,* 2001). Prior studies have reported that ERP systems decreased administrative monitoring and reporting costs as well as costs of defects and errors in product and information (Kieso *et al.,* 1989; Shin, 1999). ERP systems were also reported to enhance decision-making and decrease communication and documentation costs (Barua *et al.,* 1995; Jensen *et al.,* 1992). On the other hand, external coordination costs mainly involve operational and communications costs (Poston *et al.,* 2001). Poston *et al.* argued that accuracy and accessibility of information facilitated by ERP systems might reduce external operational and communications costs. Gurbaxani *et al.* (1991) reported that one of the benefits of ERP systems was the decrease of external operational costs through the reduction of search costs, transportation costs, and inventory holding costs.

Other studies went further to add IT excellence as a firm-level intermediate benefit of ERP. They suggested that ERP systems help achieve IT excellence, which is an important source of profitability and financial performance (Bharadwaj *et al.,* 2000; Hitt *et al.,* 1996; Lichtenberg, 1995). The general nature of this type of firm-level analysis of the relationship between large scale IT systems, including ERP systems, and firm

performance could be a primary reason why some empirical studies have found some inconsistent statistical findings. Firm-level analysis provides an incomplete understanding of the nature of the resources at play. Subunit or process-level analysis may be required to compliment the firm-level understanding and further clarify its findings. Recent field studies identified subunit-level intermediate benefits of ERP. These studies suggested that ERP systems support enhanced interdepartmental coordination and facilitate communication between departments within business units and between business units (e.g., Gattiker *et al.,* 2005; Masini, 2003).

Gattiker *et al.* (2005) surveyed 111 manufacturing plants to study the post-implementation impact of ERP systems. The authors use organizational information processing theory to postulate that the performance impact of ERP implementations could be influenced by the level of fit between information processing mechanisms and organizational context. ERP systems are viewed as a particular class of information processing mechanism. They used Tushman and Nadler's (1978) uncertainty theory to conclude that the greater the interdependence between units within an organization, the greater their need for information sharing and coordination. As such, highly integrated mechanisms such as ERP systems can therefore be beneficial when interdependence between units is high. Gatticker *et al.* (2005) also noted that highly differentiated units among the same organization might require unique and nonstandard systems to handle their particular needs and characteristics. Since ERP systems usually impose standard processes and best practices, they provide units with very little process flexibility. ERP systems may therefore be more beneficial when differentiation between units is low.

The results of the study conducted by Gatticker *et al.* (2005) confirm that ERP systems are a relatively better fit when interdependence is high and differentiation is low among subunits of the organization. The findings also show a positive role for customization and the amount of time elapsed since ERP implementation. There are therefore pathways through which ERP systems may lead to higher profits after the implementation is completed.

Masini (2003) revisited the IT productivity paradox at the process level using the RBV perspective. Masini (2003) empirically investigated the impact of ERP systems on operational effectiveness. The author believes that IT investments produce operational improvements and sustained competitive advantage only when adopters develop effective IT capabilities during and after the adoption. The study focused on companies that adopted SAP between 1996 and 2000 in North America and Europe (France, Germany, Belgium, and Italy). Although the response rate for this study was typically low, it proposed an insightful model of IT-driven performance that explains why, through which mechanisms, and under what environmental conditions IT innovations may improve operational effectiveness. Masini's (2003) empirical findings indicate that firms that operate in stable environments and display low degree of organizational rigidity exhibit higher operational effectiveness after ERP adoption.

Masini (2003) also examined how knowledge investments contributed to the development of IT capabilities. The author believes that ERP systems may play an important role in enabling knowledge and learning activities, potentially leading to improved operational effectiveness. The empirical results showed that the ERP implementation challenges related to the complexity and turbulence of organizational

environment could be effectively addressed by knowledge-intensive strategies that privilege articulation efforts. The results also suggested that ERP implementations in complex and unstable environments made it very risky to limit knowledge investments and rely exclusively on trial and error strategies.

Masini's (2003) study appears to further define the process-level pathways to performance improvement after ERP adoption. While previous researchers such as Scheer (2000) have argued that one of the main benefits of ERP systems is the improvement and standardization of business processes, Masini's (2003) study describes specific pathways to process level operational improvement following an ERP implementation. The characteristics of internal and external environments and the levels of knowledge investments are identified as critical contingent factors to ERP-induced operational effectiveness.

In short, the studies discussed above show that there are specific pathways through which ERP systems may lead to higher business performance after the implementation is completed. These pathways are theorized to influence the effectiveness of the IT capabilities cultivated by firms during and after the implementation.

2.2. Work Formalization as a Moderator of ERP Benefits

It appears that there is a growing consensus that ERP investments can lead to operational improvements and sustained competitive advantage only when adopters develop effective IT capabilities. However, there is a lack of knowledge about the mechanisms through which ERP-enabled capabilities are generated. Process level research of ERP has initiated a much needed effort to further define the pathways to IT

capabilities (e.g., Gattiker *et al.,* 2005; Masini, 2003). To fill this void in the literature, this study further explores such pathways by examining the role of work formalization as an organizational contingency factor that can potentially facilitate or hinder ERP implementations in generating ERP-enabled dynamic capabilities and enhancing business performance.

2.2.1. Contingency Perspective

Studies adopting the contingency theory perspective argue that investment alone in IT does not ensure increased performance. These studies argue that the impact of IT investments may vary from one organization to another depending on the characteristics of the environmental context within which each organization operates. Proponents of the contingency theory perspective of IT assume that the relationship between IT investments and performance may be conditional on one or more contingency factors. Organizational size is frequently thought to be one of the critical internal contingencies affecting the success or failure of IT implementations (Brynjolfsson *et al.,* 1994; Ein-Dor *et al.,* 1978; Harris *et al.,* 1991; Pavri *et al.,* 1995). Many contingency theorists have also discussed how the match between organizational strategy and IT investments may influence firm performance (Bharadwaj, 1993; Gupta *et al.,* 1984; Miller, 1988 & 1991; Porter, 1980; Prairie, 1996). Recent studies adopting a contingency theory perspective seem to touch on more dynamic contingent factors such as environmental uncertainty and turbulence, and organizational attributes. Table 2 below lists the main moderators examined by recent empirical studies to identify the pathways through which ERP systems may lead to IT capability or improved firm performance. Authors cited in Table 2 used the contingency theory perspective by itself or in conjunction with other perspectives, such

as RBV, to empirically test the proposed moderators of ERP benefits.

Table 2: Recent Empirical Findings about the Moderators of ERP Benefits

Moderators	Authors	Methodology	Sample Size
Implementation Characteristics			
The Use of Established Methodologies	Mabert *et al.* (2003)	Survey	75
Value of Consultants	Mabert *et al.* (2003)	Survey	75
Early Unresolved Problems	Markus *et al.* (2000)	Case Study	16
Length of Implementation Period	Davenport (1998)	Case Study	9
Fit of Selected System Configuration	Mabert *et al.* (2003)	Survey	75
Quality of Deliberations	Mabert *et al.* (2003) Davenport (1998)	Survey Case Study	75 9
Organization Characteristics			
Unit Interdependence	Gattiker *et al.* (2005)	Survey	129
Unit Differentiation	Gattiker *et al.* (2005)	Survey	129
Organizational Rigidity	Masini (2003)	Survey	82
Top Management Involvement	Davenport (1998)	Case Study	9
Environment Stability	Masini (2003)	Survey	82

Mabert *et al.* (2003) empirically investigated the main differences in the approaches used by US manufacturing companies that managed their ERP implementations on-time and/or on/under budget versus the ones that did not. The results of the study show that many contingent factors ranging from pre-implementation planning to system configuration may influence firm performance and the success of the ERP implementation.

Noting that many ERP focused studies provide anecdotal information based on a few successes or failures, Mabert *et al.* (2003) carried out a more systematic long-term empirical analysis of ERP. The two-phased methodology used by the authors consisted of an exploratory case study of 12 manufacturing firms using structured interviews of key managers and a confirmatory survey gathering data from 75 firms about the key areas identified in the case study, i.e., the ERP planning process, implementation decisions, management of the implementation process, timelines, and budgets.

The results of the study conducted by Mabert *et al.* (2003) suggest that upfront

planning and implementation methodology are key elements of an ERP successful implementation. Planning of education and training programs, the quality of deliberations, the value of consultants, and the fit of ERP system configuration are all found significant contingent factors common to successful implementations. Effective training programs and the hiring of expert consultants are also believed to provide managers with a better understanding of the costs related to the implementation process. The model used by Mabert *et al.* (2003) determined that modifications to the system source code to be a highly significant variable with adverse impact on implementation success. These modifications were reported to lead to increased costs and implementation time and make future upgrades to the system difficult to implement (Mabert *et al.,* 2002).

Markus *et al.* (2000) used an approach similar to Mabert *et al.* (2003) to conduct a systematic empirical study focusing on the contingent success factors of ERP implementations. However, Markus *et al.* (2000) assessed implementation success at three different points in time during the adopting organization's experience with an ERP system, i.e., the project phase, the shakedown phase, and the onward and upward phase.

The research study conducted by Markus *et al.* (2000) combined reviews of published studies and teaching cases of ERP implementations, in-depth case studies in 5 ERP adopting organizations, interviews with 11 additional ERP adopting organizations, and 20 interviews with ERP implementations consultants. Overall, 16 ERP adopting organizations directly participated in the study.

The findings suggest that researchers should use broad definitions and multiple measures of success while companies should focus on the early identification and correction of problems. Markus *et al.* (2000) stress the fact that different measures of success may be appropriate at different points in the ERP experience cycle and that the outcomes measured at one point of time may be only loosely related to outcomes measured later. The authors also noted that a critical phase in the ERP implementation planning process appears to be often unacknowledged and unfulfilled in the organizations they studied. They propose that future research should examine the factors influencing decisions made by ERP adopting organizations during the chartering phase, which defines the project objectives and decomposition, determines the level of budget to be allocated to each implementation phase, and designate an appropriate project leader and/or implementation partner.

Recent studies have also identified work formalization as an organizational attribute that can influence decisions made during the planning and adaptation process, and thus have applied the distinction between "enabling" vs. "coercive" bureaucracy to examine the forms of work formalization in a variety of organizational settings (Bigley & Roberts, 2001; Hoy, 2003; Hoy & Sweetland, 2000; Weick & Sutcliffe, 2001). These studies describe bureaucracies based on the level of their coerciveness. On the one extreme, coercive bureaucracies are those using hierarchy and excessive task formalization to impose conformity to existing procedures and routines. These bureaucracies are believed to suppress creativity, decrease predisposition to innovate, and weaken innovation effectiveness (Adler, 1999 & 2005; Arches, 1991; Kornhauser, 1962). Bennis and Slater (1968) theorize that coercive forms of bureaucracies are ineffective

forms of organization for dealing with innovation, change, and environmental complexity, which typify ERP implementations context.

On the other extreme, a number of researchers have argued that the enabling attitude of non-coercive bureaucracies empowers employees and predisposes them to innovate (Arches, 1991; Kakabadse, 1986) and modify organizational routines in order to increase process flexibility and effectiveness (Deming, 1986; Masini, 2003; Nicholson *et al.,* 1983). Studies focusing on enabling bureaucracies suggest that high levels of knowledge codification as a form of work formalization facilitates the diffusion of organizational knowledge as well as the coordination and implementation of complex activities such as ERP systems (Nonaka, 1994; Winter, 1987; Zander & Kogut, 1995).

The level of bureaucratic coerciveness characterizing work formalization in an organization plays therefore a critical role in setting up a favorable or unfavorable stage for the success ERP implementations. While enabling work formalization can potentially predispose employees to innovate and facilitate the diffusion of knowledge, coercive work formalization can hinder the success of ERP implementations by suppressing creativity and slowing down the adaptation process.

2.2.2. Resource-Based View Perspective

Several researchers have adopted the resource-based view of the firm perspective to argue that IT resources per se do not provide sustained competitive advantages. It is the ability of firms to create and sustain unique organizational capabilities from IT investments that impact a firm's overall effectiveness (Clemons *et al.,* 1991; Duliba *et al.,* 2001; Mata *et al.,* 1995; Ross *et al.,* 1996). The RBV assumes that firms could obtain competitive advantages on the basis of corporate resources that are firm specific,

valuable, rare, imperfectly imitable, and not strategically substitutable by other resources (Barney, 1991).

The RBV perspective of IT suggests that ERP systems may enable firms to generate organizational capabilities. In light of the uncertainty about the benefits of ERP investments, proponents of the resource-based perspective of IT have argued that ERP systems are beneficial only if they are accompanied by the development of effective IT capabilities (Bharadwaj, 2000). However, there seem to be a lack of knowledge about the mechanisms by which these capabilities are developed and how the impacts of ERP-generated capabilities on business performance vary with different implementation strategies and various organizational settings. Several researchers and practitioners have, however, recognized that ERP systems should not be simply viewed as tools with a fixed measurable output, but rather as technological infrastructures designed to support the capability of all other processes in an organization (Bendoly, 2004).

The theory of dynamic capabilities, which can be viewed as an extension of the resource-based view perspective, suggests that a process-oriented technology, such as ERP systems, should enhance the firm's ability to promptly reconfigure its organizational processes and routines to address rapidly changing markets (Teece *et al.,* 1997). This capacity is mirrored by the effectiveness and flexibility of the organization operational processes. ERP implementations may interact with certain organizational attributes through which dynamic capabilities are generated and therefore affect organizational performance. Specifically, the ultimate impact of ERP implementations on business performance may depend on how work formalization interacts with ERP implementation in yielding operational enablers of dynamic capabilities, which are business performance

drivers.

Although the extant ERP-performance research has evolved around two separate themes of contingency and RBV perspectives, it is contended that these two different perspectives can jointly operate in providing a stronger theoretical grounding for ERP-business performance research, thus potentially resulting in a more complete picture of how ERP implementation can influence business performance. This study is an attempt to provide a solid bridge between contingency and RBV perspectives in explaining the process-level mechanisms through which ERP implementation affects business performance. The existing literature that initiated this bridge at the process level appears to be limited and still at an embryonic stage (Gattiker, 2005; Masini, 2003). I specifically propose that work formalization moderates the relationship between ERP implementation and operational enablers of dynamic capabilities, which in turn, influence business performance. My theoretical model and propositions are discussed in more details in the next section.

2.3. Theoretical Framework

2.3.1. Theoretical Model

This study applies the distinction between enabling vs. coercive work formalization to examine the moderating effect of work formalization on operational enablers of dynamic capabilities, which in turn, influence business performance in the context of ERP implementations. ERP pathways to dynamic capabilities and business performance are described using work formalization as an organizational attribute characterizing the conditions under which systems are implemented. The proposed

framework shown in Figure 2 combines both the contingency theory perspective and the resource-based view perspective (RBV) of IT in an attempt to understand the moderating effect of the type of work formalization on the development of ERP-enabled dynamic capabilities and the resultant business performance improvement.

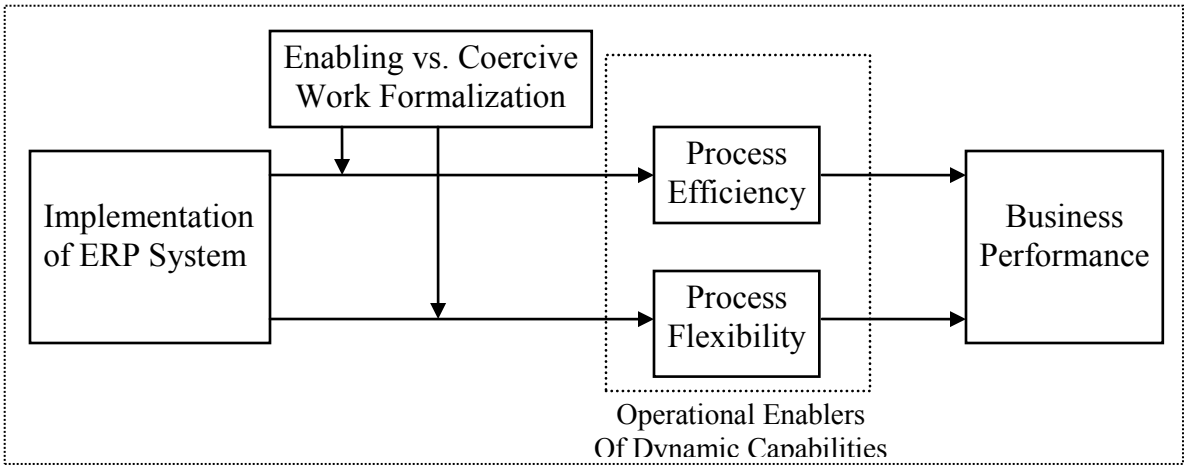


Figure 2: Research Model

2.3.2. Enabling Work Formalization as a Pathway to Process Efficiency

ERP implementation can be viewed as an instrument that may be used as an organizational control mechanism producing rigid and inefficient processes or as an exploration tool continuously revamping process efficiency. Organizations displaying coercive forms of work formalization emphasize the importance of conformity to procedures and routines (Adler, 1999, 2005; Arches, 1991). These organizations are more likely to use ERP as a control instrument that suppresses employee creativity and decreases their predisposition to innovate or change exiting operational procedures to improve the efficiency of organizational processes. The coercive form of work formalization is likely to lead these organizations to impose the best practices proposed by the ERP package and limit the opportunities for employees to innovate and be creative

in adapting existing routines to the applicable best practices. This situation may slow down the knowledge transfer process and increase implementation costs, which can negatively impact process efficiency.

On the other hand, organizations with a mostly enabling form of work formalization empower employees and predispose them to innovate (Arches, 1991; Kakabadse, 1986). These organizations are more likely to use ERP implementations as an exploration tool that encourages employees to continuously look for new ways of executing the tasks, leading to more efficient process structures, and resource allocation plans. Work formalization in its most enabling form supports the coordination and implementation of complex activities related to ERP implementations mainly through facilitating the diffusion of organizational knowledge (Nonaka, 1994; Winter, 1987; Zander & Kogut, 1995). Knowledge articulation and codification are learning mechanisms allowing individuals to share their experiences and understandings of the performance implications of routines and processes through developing manuals, spreadsheets, decision support systems, and other descriptive process-specific tools. Aiming these learning mechanisms at enabling individuals to uncover the causal links between the decisions to be made regarding the ERP implementation and the performance outcomes to be expected facilitates the diffusion and replication of the new organizational knowledge created throughout the implementation process (Zollo & Winter, 2002). Work formalization via these learning mechanisms may reduce the time required to create and acquire the knowledge used to operate efficiently within the newly reconfigured work structure.

ERP adopters with high levels of enabling work standardization are also believed to achieve higher organizational integration at lower coordination costs as most of their tasks and processes are already highly standardized and routinized. Enabling work formalization typically uses mechanisms such as job enrichment and meta-routines that encourage individuals to continuously and methodically be involved in innovation activities that enhance process efficiency, even when they are performing routine tasks (Barki, 2005).

The type of work formalization may also influence an ERP adopter's ability to internalize the ERP mandated standardized processes into business routines that provide enhanced process efficiency. ERP implementations often require the transfer of the business knowledge built in the implemented software systems into the adopting organization (Zoonky *et al.,* 2000). While customization of ERP systems is possible, the associated high costs have led ERP adopters to go with "vanilla" implementations and to align their processes to the business process models of the implemented package. Davenport (1998, 2004) observed that ERP systems impose their specific logic on adopters' strategy, organization, and culture. Previous studies have shown that high levels codification may increase the speed of this computer-based and enterprise wide knowledge transfer and therefore help ERP implementations achieve greater efficiencies (Zander *et al.,* 1995, 2002). If this codification or work formalization has a mainly enabling character, it will particularly enhance the adopters' adaptive capability in regards to responsibility and role distribution and therefore impact the adopters' capability to internalize the best practices imposed by the ERP package into routines that potentially provide enhanced process efficiency (Zoonky, 2000). On the other hand, work

formalization in its coercive form would hinder its process efficiency benefits because it is believed to suppress creativity, decrease predisposition to innovate or to make continuous improvement on exiting processes (Kornhauser, 1962; Adler, 1999, 2005; Arches, 1991).

The above arguments collectively suggest the following general hypothesis:

Hypothesis 1: *The relationship between ERP implementation and process efficiency is moderated by the form of work formalization.*

Specifically, the literature review suggests the following two hypotheses:

H1a:Under enabling work formalization, ERP implementation is positively related to process efficiency.

H1b:Under coercive work formalization, ERP implementation is negatively related to process efficiency.

Figure 3: Hypothesized Moderating Effect of the Form of Work Formalization on Process Efficiency

Form of Work Formalization	**Process Efficiency**	
	ERP Implementers	**Non-ERP Firms**
Enabling	Very High	High
Coercive	Very Low	Low

2.3.2. Enabling Work Formalization as a Pathway to Process Flexibility

Highly enabling work formalization helps ERP adopters not only to achieve greater efficiencies but also higher flexibility. The enabling form of knowledge articulation and codification in non-coercive organizations may encourage the identification of the relative strengths and weaknesses of the ERP suggested best

practices and may lead to a cost-effective generation of new proposals to change existing routines in order to adopt the applicable best practices. By supporting the diffusion of organizational knowledge during and after ERP implementations, the enabling form of work formalization may also facilitate employee adaptation to the ERP dictated new processes and may lead to an incremental increase in process flexibility. This organizational ability to rapidly develop and deploy critical IT systems represents the organization's change-readiness capability (Clark *et al.,* 1997). This dynamic capability is one of the factors that determine the strategic flexibility of the firm (Grant, 1991).

On the other hand, since coercive bureaucracies try to limit employees' creative intervention in the implementation process, they are likely to force employees to use the ERP system "as is", i.e., vanilla implementations, without having the necessary organizational knowledge diffusion mechanisms and the required innovative capabilities in place. This may limit the employees' level of understanding of the linkages between actions and performance outcomes and may therefore hinder their ability to change routines to adapt to the ERP mandated processes and to environmental changes.

These arguments suggest the following general hypothesis:

Hypothesis 2: *The relationship between ERP implementation and process flexibility is moderated by the form of work formalization.*

Specifically, the literature review suggests the following two hypotheses:

H2a:Under enabling work formalization, ERP implementation is positively related to process flexibility.

H2b:Under coercive work formalization, ERP implementation is negatively related to process flexibility.

Figure 4: Hypothesized Moderating Effect of the Form of Work Formalization on Process Flexibility

Form of Work Formalization	**Process Flexibility**	
	ERP Implementers	**Non-ERP Firms**
Enabling	Very High	High
Coercive	Very Low	Low

2.3.3. Enabling Work Formalization as a Pathway to Business Performance

By enhancing process efficiency and process flexibility, ERP is believed to have the potential to enhance business performance. ERP alters the mechanisms through which firms generate effective operational improvements (Masini, 2003). As discussed in the previous section, a successful alteration of these mechanisms leads to process-level operational enablers through which dynamic capabilities are generated. The RBV and Dynamic Capabilities literature suggests that these scarce and difficult-to-imitate dynamic capabilities accrue economic rents and provide competitive advantage to their owners (Teece, 1997). Therefore, it is argued that the ERP stimulates the organizational operational enablers of dynamic capabilities, which in turn, help to achieve higher business performance. This indirect effect will tested using a two-step approach.

Process efficiency and process flexibility are believed to be positively related to business performance. The following hypotheses are therefore formulated:

Hypothesis 3: *Process efficiency is positively related to business performance.*

Hypothesis 4: *Process flexibility is positively related to business performance.*

Since the form of work formalization is believed to play a significant role in moderating the impact of ERP implementations on process efficiency and process flexibility, it is theorized to moderate the effect of ERP implementations on business performance. The mixed findings regarding the relationship between ERP implementations and business performance suggest that operational enablers of dynamic capabilities may not necessarily play a mediating role in this relationship. But rather, it is theorized that there is an indirect effect of ERP implementation on business performance. As such, a competing model is introduced to test the mediating effect of process efficiency and process flexibility.

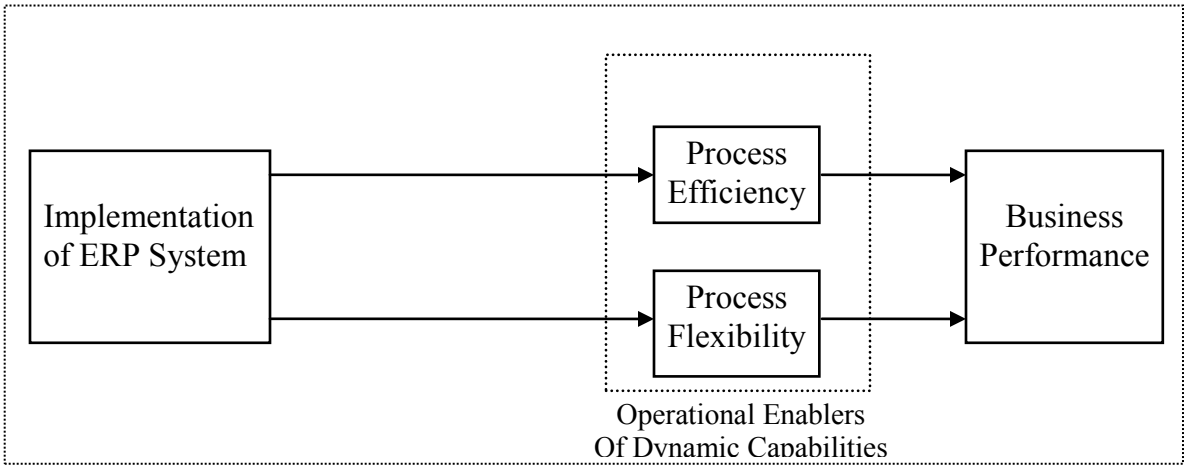


Figure 5: The Mediating Effect of Operational Enablers of Dynamic Capabilities

The following two hypotheses will be tested:

Hypothesis 5: *The relationship between ERP implementation and business performance is mediated by process efficiency.*

Hypothesis 6: *The relationship between ERP implementation and business performance is mediated by process flexibility.*

Figure 6 below summarizes all the hypothesized effects tested in this study.

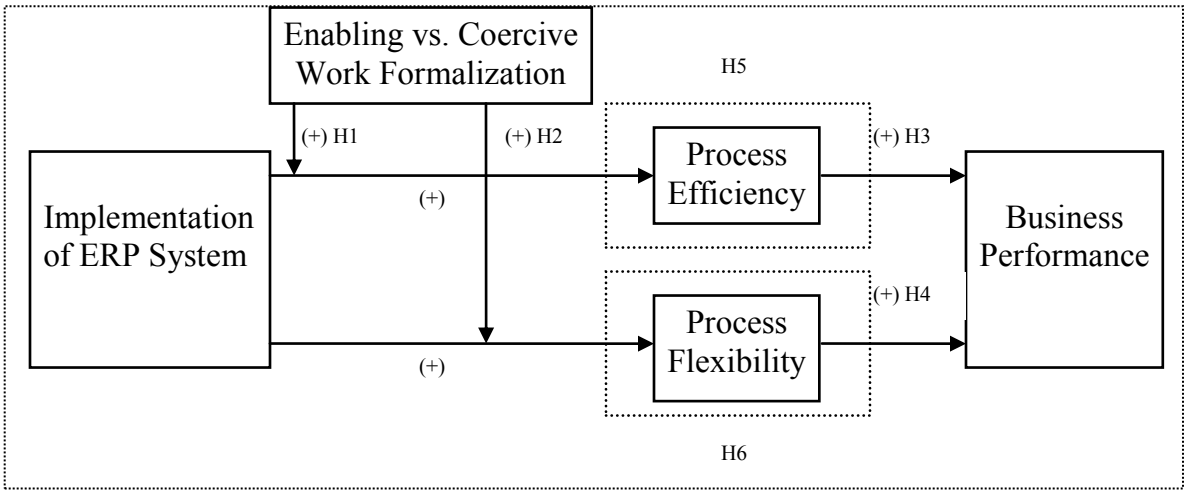


Figure 6: Hypothesized Effects

Chapter 3: Methodology

The purpose of this chapter is to describe the procedures used for the investigation and testing of the hypotheses. Prior to detailed examination of each of the steps used in creating the questionnaires and administering the questionnaires, I present an outline of the methods used. This study followed Masini (2003) and Davenport (2004) studies in that it uses a quantitative analysis of information obtained from surveys of managers at organizations with Enterprise Systems. I carried out a cross-sectional study examining a sample of US firms to tackle the research questions and empirically examine the hypotheses presented in the previous section. ERP-adopting firms were matched with a control group of non-ERP adopting firms by size, industry, and other financial variables. A questionnaire was used to gather data from a sample of firms that had recently adopted an ERP system as well as those not using an ERP system. This chapter addresses the methods: (1) research design, (2) sample, (3) measurement, and (4) initial analysis plan.

3.1. Research Design

This non-experimental field study utilizes survey research. This method of data collection is chosen because: (1) Gall, Borg, and Gall (1996) indicate that survey research is a useful tool for studying sensitive opinions, attitudes, preferences, and behaviors of individuals, particularly when the opinions are reflections of larger underlying attitudinal constructs and (2) my goal was to collect the data using a questionnaire that could be analyzed in a short period of time and with a minimum of expense. Because I expected some skewness in the data, to provide comprehensive analysis, factor analysis, and regression analysis methods were utilized to discover patterns of relationship among the variables.

Factor analysis was used to ensure the identified dimensions for each variable are unidimensional and to reduce survey items into composite measures for each construct. It was also used to help confirm the nature of the variables introduced in the model being tested, i.e., dependent vs. independent variables. The dependent variables were symmetrically (normally) distributed and intervally-scaled. The independent variables were treated as nominal.

3.2. Study Population

Sampling is the process of selecting a relatively small number of subjects (research participants) from a larger defined group of people so that the information gathered from the smaller group allows one to make judgments about the larger group of people. There are, however, several important sampling issues that need to be considered when doing survey research. For one, an error can occur if a sample is drawn from an incomplete list of prospective respondents. The main issues and their possible solutions are as follows:

Figure 7 summarizes the main steps used in building the sample for this study. The unit of analysis is the firm while the unit of observation is the manager with whom the empirical observations through survey would eventually take place. To identify firms using ERP systems, the public customer databases published on major ERP vendors' websites, ERP user-groups companies, and ERP consultants' clients were used. Each ERP-adopting firm was matched with a control group firm based on size, industry, and financial variables. Firms were matched by the four-digit Standard Industrial Classification (SIC) code then matched by size, using total annual sales and number of employees. The contact names were developed from professional associations such as the

Association for Operations Management (APICS), the Association for Information Technology Professionals (AITP), and the Association of Chartered Accountants in the United States (ACAUS).

1000 US public firms were contacted: 500 using ERP systems matched with a control group based on industry and size. The participants were contacted via email and participation was done online. Also, I used some Tailored Design Method techniques such as follow-ups, online surveys, endorsement from ERP vendor, sharing results with vendor and participants.

The sample was cross-matched with the Compustat Global database to eliminate non-public firms and firms that were recently involved in mergers and acquisitions. The database provides normalized fundamental data covering approximately 37,000 active and inactive global companies, in over 80 countries, including the US. The sample includes some representation of those industries known for their typical bureaucratic organizational structure.

A detailed questionnaire was administered to measure the main constructs, i.e., work formalization, enablers of operational capabilities, ERP implementation, and business performance. The questionnaire used a combination of multiple previously validated scales to measure the variables of interest. The questionnaire was submitted to a pilot pretest. The purpose of the pilot study was to make sure the instrument is clearly worded and makes sense to 50 managers and 50 MBA students. The MBA students were selected to be part of the pretest process for convenience purposes; nevertheless, studies in student-manager surrogacy suggest that MBA students have similar decision-making patterns to those of actual managers in various decision-making contexts and thus can be

used as reasonable surrogates for the managers (e.g., Bateman & Zeithaml, 1989; Ford & Hegarty, 1984; Remus, 1986; Corfman & Lehmann, 1994).

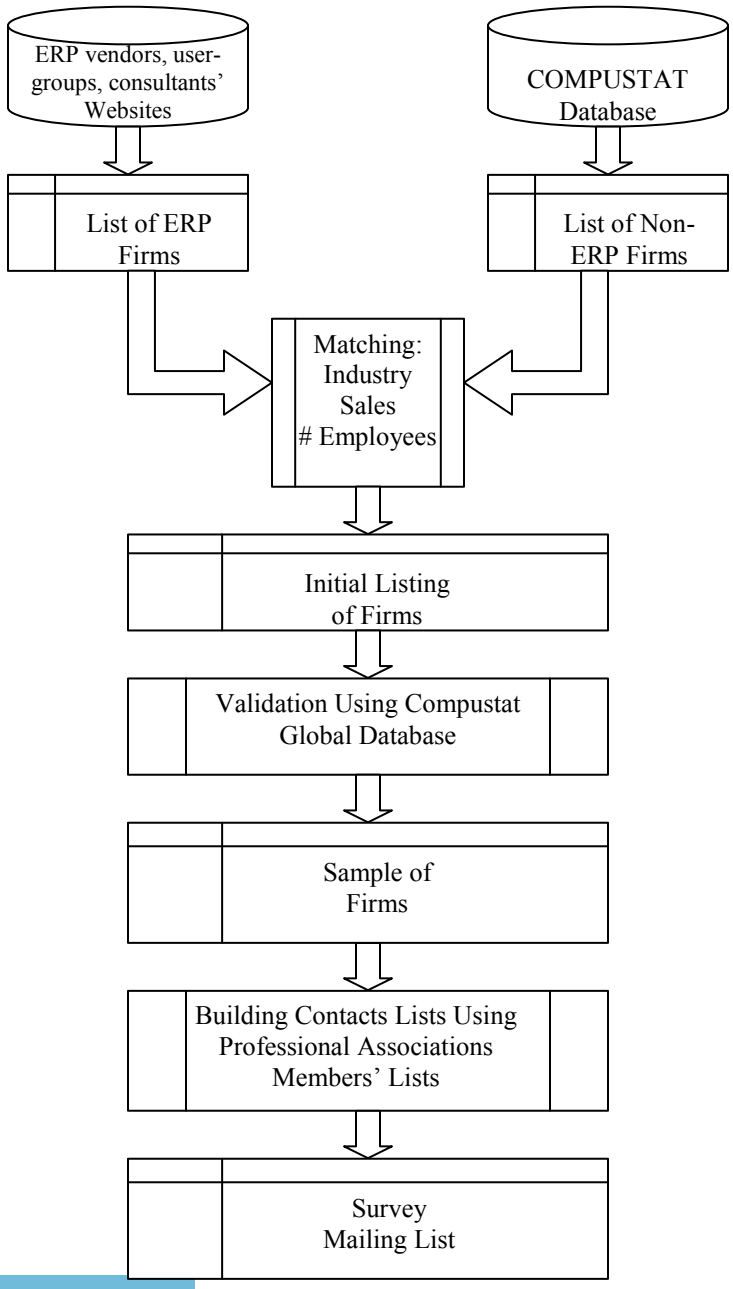
The wording and formatting of the questionnaire was changed based on the results of the pilot testing. Most managers and students thought that the use of a combination of 5-point and 7-point scales was confusing. As a result all the scales were changed to 7-point scales. Some respondents expressed difficulty understanding the basis for perceptual performance comparisons. Both profitability and sales growth were therefore highlighted in the questionnaire. Finally, the questionnaire's introduction and the introductions to each section in the questionnaire were reworded based on the feedback received from the respondents. For example, the introduction to the work formalization section was reworded to specify that the procedures are to be rated at the organization level and not the department or division level. Appendix B shows the revised version of the questionnaire which was used to collect the data for this study.

The initial pilot was conducted to make sure the instrument is clearly worded and makes sense to 50 managers and 50 MBA students. The responses were statistically analyzed and the scales were found reliable.

The questionnaires were administered via email to middle managers directly or indirectly involved in the implementation process. The managers were directed to use SurveyMonkey.com to submit their responses. Figure 7 shows the main steps used to build the sample and contact participants. The main advantages of web-based surveys are that they are inexpensive and allow the respondents (managers) to answer at their leisure. Another advantage of web-based surveys is that I can send the exact same data collection instrument to a wide number of people.

To solve confidentiality issues, all the subjects were assured that their names would not be disclosed and confidentiality would be assured. In addition, all the managers were requested not to disclose their name on the questionnaire. Since the research was based on the survey questionnaire, the respondents (managers) were not forced to respond to each specific question.

Figure 7: Sampling Procedures



3.3. Measurement

To remain consistent with previous research, measures used in this study were taken from three prior studies. All of the measures pertaining to business performance were taken from Dooms *et al.'s* (2005). The scales validated by Masini (2003) were used to measure operational enablers of dynamic. Coercive and enabling aspects of work formalization were taken from Likert-type scales validated by Hoy and Sweetland's (2001) and McGuigan's (2005). Based on respondents' responses during the pretest, changes in the questionnaire were made (e.g., some of the items were deleted, or more explanations and descriptions were included). Following is the detailed description of how the measures were obtained.

3.3.1. Dependent Variables: Business Performance

Business performance was measured as an organization's average performance in terms of profitability and sales growth compared to three benchmarks: performance of the most direct competitor, performance in previous years, and expectations of leadership. Dooms *et al.* (2005) developed the six-item tolerance-of-freedom scale (alpha=.86), which measures perceived profitability and sales growth. Respondents are asked to compare the profitability and sales growth of their organization to the three benchmarks:

- Goals and objectives set by top management,
- Performance in previous years, and
- Performance of the most direct competitor.

As shown in Appendix B, I have selected all six items that are the most suitable for my study to measure the "business performance" variable. Perceived performance was used as a proxy for actual performance. This stand has been supported by previous

research (Anderson *et al.,* 1995; Brown *et al.,* 2000; Dean and Snell, 1996; Ketokivi *et al.,* 2004; Vickery *et al.,* 1993).

The respondents were asked to rate each item on a seven-point scale ranging from (1) "Much Worse" to (7) "Much Better." Higher scores on each item indicate higher average performance. Dooms *et al.* (2005) reported a Cronbach alpha of .86 for six items. Based on the convenient pretest sample of 50 MBA students and 50 managers, the above scale was shown to be reliable with a Cronbach alpha of .97. The results provided confidence in using the scale in the full sample.

3.3.2. Mediating Variable: Enablers of Operational Capability.

Enablers of operational capabilities were measured using two average scores for process efficiency and process flexibility. Masini (2003) empirically developed and validated measures for the operational enablers of dynamic capabilities associated with ERP implementations (alpha=.70). The author identified eight parameters linked to Swanson's three-core framework (1994). As shown in Appendix B, I have selected five items that are the most suitable for my study:

- The ability of an organization to deal with unexpected events.
- The ability of an organization to reallocate resources across functions.
- The ability of an organization to modify processes.
- The amount of time necessary to execute tasks.
- The amount of resources necessary to execute tasks.

The respondents were asked to rate each item on a seven-point scale ranging from (1) "Poor" to (7) "Excellent" for ability and from (1) "Very Limited" to "Very Large" for amounts. Higher scores on each item indicate higher average process efficiency or process

flexibility. A factor analysis was performed to come up with a composite score combining the uncorrelated items. Higher scores on each item indicate higher agreement with process efficiency or process flexibility. Uncorrelated items of the operational enablers of dynamic capabilities were averaged to come up with two scores rating process flexibility and process efficiency. Based on the convenient pretest sample of 50 MBA students and 50 managers, the above scale was shown to be reliable with a Cronbach alpha of .80 for Process Efficiency and .91 for Process Flexibility. The results provided confidence in using the scale in the full sample.

3.3.3. Moderating Variable: Work Formalization.

The form of work formalization was measured using a composite score combining four items rating the coercive aspect of work formalization and four items rating the enabling aspect of work formalization. Sweetland (2001) and McGuigan (2005) validated Likert-type scales composed of twelve items measuring the form of work formalization. As shown in Appendix B, I have selected eight of the twelve items that are the most suitable for my study.

The enabling aspect of work formalization was be assessed using the following descriptions of the administrative rules and procedures:

- Administrative procedures of the organization that enable authentic communication between managers and employees.
- Administrative procedures of the organization that enable employees to do their jobs.
- Administrative procedures of the organization that help rather than hinder task execution.

- Administrative rules of the organization that provide guidelines to solutions rather than rigid procedures.

The coercive aspect of work formalization was assessed using the following descriptions of the administrative rules and procedures:

- Administrative rules of the organization that are used to punish employees.
- Administrative procedures of the organization that obstruct innovation.
- Administrative procedures of the organization that are considered substitutes for professional judgment.
- Managers of the organization who use administrative procedures to undermine employees.

The respondents were asked to rate each item on a seven-point scale ranging from (1) "Strongly Disagree" to (7) "Strongly Agree." The form of work formalization will be treated as a continuum. A factor analysis was performed to come up with a composite score combining the uncorrelated items. Higher scores on each item indicate higher agreement with the enabling or coercive aspect of work formalization. McGuigan (2005) reported a Cronbach alpha > 0.90 for twelve items. Based on the convenient pretest sample of 50 MBA students and 50 managers, the above scale was shown to be reliable with a Cronbach alpha of .89. The results provided confidence in using the scale in the full sample.

3.3.4. Independent Variable: ERP Implementation.

The treatment variable in this study has two levels: ERP implementers and Non-ERP implementers. Since ERP implementation is categorical, it was coded as a dummy

variable to be applied in regression analysis and other quantitative statistical tests. ERP implementers were coded as a 1 and non-ERP implementers were coded as a 0.

3.3.5. Additional ERP Implementation Information.

This study collected additional variables that may directly interfere with the ERP implementation's impact on business performance and operational enablers of dynamic capabilities. The respondents were asked to specify the following characteristics:

- ERP systems implemented,
- ERP vendor,
- ERP modules implemented (Full or partial),
- ERP system go live date,
- Firm's number of employees,
- Firm's annual sales volume.

These variables were used as control variables, to perform further data analysis and to identify areas for future research in the final dissertation. Most control variables are formulated in a categorical format to avoid asking respondents for precise numbers. Participants do not necessarily know the exact figures for these variables. Requiring precise numbers to be entered may negatively impact the response rate. All control variables available in Compustat will be cross-checked. Firm size and sales volume are commonly used in similar studies as control variables. I also added industry as a control variable. Data from Compustat provides some objective financial variables that can also be useful control variables.

3.4. Data Analysis

The overall objective of the statistical analysis is to examine whether the type of work formalization (enabling vs. coercive) has a moderating role in the relationship between ERP implementation and business performance and towards what direction it exerts its influence. Factor analysis and linear regression was used to explore all of the hypothesized relationships.

Figure 7 summarizes the main steps used to analyze data and test the moderating effect of work formalization. As described in the figure, the first major step in data analysis was to submit the validated scales used in the questionnaire to a confirmatory factor analysis to ensure the identified dimensions are unidimensional and to reduce survey items into a single composite measure for each construct. The type of work formalization, the operational enablers of dynamic capabilities as well as business performance were examined to determine the extent to which each variable is explained by the various dimensions. Rotated factor patterns as well as the commonality and the proportion of variance explained by each factor were computed for the pooled sample. This helped to come up with composite scores combining the uncorrelated items for operational enablers of dynamic capabilities and business performance.

Figure 8: Data Analysis Summary

STEP 1: CONFIRMATORY FACTOR ANALYSIS		
	Ensure the validated scales used in the questionnaire to measure the following dimensions are uncorrelated and to reduce survey items into a single composite measure for each construct: • Type of work formalization, • Operational enablers of dynamic capabilities • Business performance	

STEP 2: SUB-GROUP ANALYSIS		
	Examine whether the sub-group of firms with predominantly enabling work formalization and the sub-group of firms with predominantly coercive work formalization are significantly different with respect to the following relationships: • ERP implementation-process efficiency, • ERP implementation-process flexibility Techniques to be used: Moderated regression analysis.. ***Expected Results:*** Regression estimates for each sub-group are expected to be significantly different.	

STEP 3: MODERATED REGRESSION ANALYSIS		
	Test whether work formalization acts as a pure moderator, a quasi-moderator, or a simple predictor. Three regression models will be tested for each dependent variable: **Model 1** will include the main effect of ERP implementation and will not include the moderator variable, i.e., the type of work formalization. **Model 2** will add the type of formalization as a direct predictor to the base model. **Model 3** will extend the second model by including the cross products of the type of work formalization and ERP implementation The appropriateness of the proposed contingency model will be assessed by comparing R^2 of the models. ***Expected Results:*** The type of formalization is expected to act as a pure or quasi moderator for the effect of ERP implementation on process efficiency, process flexibility, and business performance. The enabling type of work formalization is expected to significantly amplify the hypothesized positive effects of ERP implementations.	

Moderated regression analysis was used to test whether work formalization acts as a pure moderator, a quasi-moderator, or a simple predictor. Regression estimates for each sub-group are expected to be significantly different. Moderated regression analysis is an appropriate technique to more directly test for interaction effects and determine the nature of the impact of the hypothesized moderator, as this analysis does not alter the test of significance of the interaction terms (Southwood, 1978). Following recommendations formulated by Aiken and West (1991) and Sharma et al. (1981), three regression models were tested for each dependent variable. The first model includes the main effect of ERP implementation and does not include the moderator variable, i.e., the type of work formalization. The following are the corresponding regression equations:

(3.4.1) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3$

(3.4.2) $Y_2 = B_0 + B_1X_1 + B_2X_2 + B_3X_3$

where Y_1 = process efficiency, Y_2 = process flexibility, X_1 = ERP Implementation, X_2 = firm size, X_3 = sales volume, and the B's are the parameter estimates.

The second model adds the type of formalization as a direct predictor to the base model. The following are the corresponding regression equations:

(3.4.3) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$

(3.4.4) $Y_2 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$

where Y_1 = process efficiency, Y_2 = process flexibility, X_1 = ERP Implementation, X_2 = firm size, X_3 = sales volume, X_4 = work formalization, and the B's are the parameter estimates.

The third model extends the second model by including the cross products of the type of work formalization and ERP implementation. The following are the corresponding regression equations:

(3.4.5) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_1X_4$

(3.4.6) $Y_2 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_1X_4$

where Y_1 = process efficiency, Y_2 = process flexibility, X_1 = ERP Implementation, X_2 = firm size, X_3 = sales volume, X_4 = work formalization, and the B's are the parameter estimates.

The appropriateness of the proposed contingency model was assessed by comparing R^2 of the models. The type of work formalization is found a pure moderator if significant statistical difference is observed only between the first and third model. If the significant difference is found only between the first and second model, then the type of formalization is a pure predictor. Finally, if all three models show significant statistical difference, then the type of formalization is a quasi-moderator.

The type of formalization is expected to act as a pure or quasi moderator for the effect of ERP implementation on process efficiency, process flexibility, and business performance. The enabling type of work formalization is expected to significantly amplify the hypothesized positive effects of ERP implementations. Figure 9a, 9b, and 9c illustrate the expected moderating effect of the type of work formalization on the dependent variables.

Figure 9A: Hypothesized Moderating Effect of the Type of Work Formalization on Process Efficiency

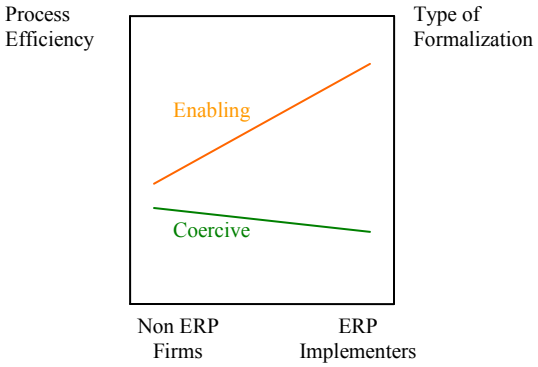
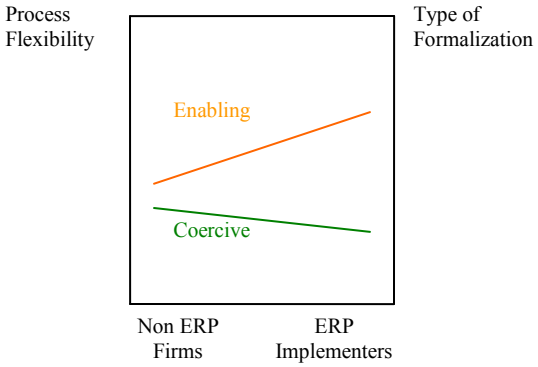


Figure 9B: Hypothesized Moderating Effect of the Type of Work Formalization on Process Flexibility



Regression analysis was performed to test the mediating effect of the operational enablers of dynamic capabilities. Transformed data was used for the regressions. To determine the relationship between two variables through regression analysis, the average scores of the mediating variable (e.g., ***operational enablers of dynamic capabilities***) was related on a factor with the average scores of the dependent variable [e.g., ***business performance***]. To test the hypotheses, $p < .05$ significance level was used to accept or reject a null hypothesis.

Following recommendations formulated by Baron and Kenny (1986), three regression equations were estimated to test the mediating effect of operational enablers of dynamic capabilities.

First, process efficiency and process flexibility were regressed on ERP implementation.

The following are the corresponding regression equations:

(3.4.7) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3$

(3.4.8) $Y_2 = B_0 + B_1X_1 + B_2X_2 + B_3X_3$

where Y_1 = process efficiency, Y_2 = process flexibility, X_1 = ERP Implementation, X_2 = firm size, X_3 = sales volume, and the B's are the parameter estimates.

Second, business performance was regressed on ERP implementation. The following is the corresponding regression equation:

(3.4.9) $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3$

where Y = business performance, X_1 = ERP Implementation, X_2 = firm size, X_3=sales volume, and the B's are the parameter estimates.

Third, business performance was regressed on both ERP implementation and process efficiency and process flexibility. The following are the corresponding regression equations:

(3.4.10) $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$

where Y = business performance, X_1 = ERP Implementation, X_2 = process efficiency, X_3 =firm size, X_4 = sales volume, and the B's are the parameter estimates.

(3.4.11) $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$

where Y = business performance, X_1 = ERP Implementation, X_2 = process flexibility, X_3 = firm size, X_4 = sales volume, and the B's are the parameter estimates.

According to Baron and Kenny (1986), three conditions must hold to establish mediation. First, ERP implementation must affect the operational enablers of dynamic capabilities (3.4.5 and 3.4.6). Second, ERP implementation must be shown to affect business performance (3.4.7). Third, operational enablers of dynamic capabilities must

affect business performance (3.4.8 and 3.4.9). If all these conditions hold in the predicted direction, then the effect of ERP implementation on business performance must be less in the third set of equations than in the second set of equations to confirm the mediating effect of operational enablers of dynamic capabilities.

Table 3 presents a summary of all the hypotheses indicating the statistical method used to test the hypotheses

Table 3: Statistical Methods Testing Hypotheses

Hypotheses	**Methods**
Hypothesis 1: The relationship between ERP implementation and process efficiency is moderated by the form of work formalization. Specifically, the literature review suggests the following two hypotheses: H1a:Under enabling work formalization, ERP implementation is positively related to process efficiency. H1b:Under coercive work formalization, ERP implementation is negatively related to process efficiency. Hypothesis 2: The relationship between ERP implementation and process flexibility is moderated by the form of work formalization. Specifically, the literature review suggests the following two hypotheses: H2a:Under enabling work formalization, ERP implementation is positively related to process flexibility. H2b:Under coercive work formalization, ERP implementation is negatively related to process flexibility.	• Confirmatory factor analysis • Moderated regression analysis

Table 3: Statistical Methods Testing Hypotheses (continued)

Hypotheses	**Methods**
Hypothesis 3: Process efficiency is positively related to business performance. Hypothesis 4: Process flexibility is positively related to business performance. Hypothesis 5: The relationship between ERP implementation and business performance is mediated by process efficiency.	• Regression analysis
Hypothesis 6: The relationship between ERP implementation and business performance is mediated by process flexibility.	• Regression analysis

Chapter 4: Results

The purpose of this chapter is to describe the data resulting from the research procedures and then interpret those results to test the hypotheses. This chapter empirically explores the pathway through which ERP may boost organizational enablers of dynamic capabilities, which in turn, enhance business performance in the context of ERP implementations. The first section presents descriptive statistics about the sample. The second section discusses the results of outliers' testing. The third section shows the results of exploratory and confirmatory factor analyses. The last section in this chapter interprets the results of regression analyses to test the various hypotheses in this study.

4.1. Representativeness of the Sample

Five hundred companies using ERP systems were matched with a control group based on industry and size. The managers were asked to rate their organization's current work formalization, process efficiency, process flexibility, and business performance. Of the 1000 questionnaires sent out, a response rate of 24.4% was attained; the remaining non-respondent organizations were similar in size to the responding organizations. This response rate is comparable to that of studies of similar nature (Mabert *et al.,* 1999; Prater *et al.,* 2006, Cycyota *et al.,* 2006). Given the length and comprehensive nature of the survey, this response rate was concluded to be reasonable.

This research used the following response-enhancing techniques:

- Respondents anonymity
- Advance notice

- Follow-ups
- Offer to share results of the study.

Non-response bias was checked by comparing early and late respondents, using Chi-Square tests (Hair *et al.,* 1998). More specifically, the first 122 received surveys and the last 122 received surveys were compared, using demographic variables (Number of Employees and Sales Volume) and ERP Implementation. Results showed no significant difference between both groups ($p>0.05$), suggesting that non-response bias is not an issue.

Common method bias arises due to common method variance, which is the variance attributable to the measurement method used rather than to the constructs (Podsakoff *et al.,* 2003). Common method bias was assessed by performing Harman's single-factor test (McFarlin & Sweeeney, 1992). No significant common method bias was found.

Descriptive statistics summarizing the characteristics of this sample are reported in the table 4. Companies of all sized based on the number of employees and the volume of sales were represented in the sample.

Table 4: Firm Demographics of for Sampled Companies

		Count	***Percentage***
Number of Employees	*Less than 25*	*14*	*6%*
	25-99	*14*	*6%*
	100-499	*42*	*17%*
	500-999	*36*	*15%*
	1,000-4,999	*70*	*29%*
	5,000-9,999	*42*	*17%*
	10,000 and over	*26*	*11%*
	Total	***244***	***100%***
Sales	Less than $1 million	*16*	*7%*
	$1-9.99 million	*32*	*13%*
	$10-49.99 million	*20*	*8%*
	$50-99.99 million	*46*	*19%*
	$100-499.99 million	*50*	*20%*
	$500-999.99 million	*44*	*18%*
	$1 billion or more	*36*	*15%*
	Total	***244***	***100%***

Given the nature of this study, we paid special attention to verify whether the sample retained for statistical analysis was representative of both ERP-adopting firms and non-ERP-adopting firms (control group). The table below shows that 120 responses (49% of total responses) originated from non-ERP-adopting firms.

Table 5: Technical Demographics of Sampled Companies

		Count	*Percentage*
ERP vs. Non-ERP	*Non-ERP*	*120*	*49%*
	Oracle	*20*	*8%*
	PeopleSoft	*35*	*14%*
	SAP	*21*	*9%*
	Other	*48*	*20%*
	Total	***244***	***100%***
Time of ERP Use	*Less than 2 years*	*30*	*12%*
	2 to 5 years	*36*	*15%*
	5 to 10 years	*41*	*13%*
	More than 10 years	*17*	*17%*
	NA	*120*	*49%*
	Total	***244***	***100%***
Go Live Date	*Less than 2 years ago*	*58*	*24%*
	2 to 5 years ago	*42*	*17%*
	More than 5 years ago	*24*	*10%*
	NA	*120*	*49%*
	Total	***244***	***100%***
Modules Implemented	*Full implementation*	*46*	*19%*
	Partial implementation	*78*	*32%*
	NA	*120*	*49%*
	Total	***244***	***100%***

Correlatons between the major constructs and control variables were computed. Table 6 provides a summary of the results.

Table 6: Correlation Matrix

Correlations		Business Performance	Process Efficiency	Process Flexibility	Type of Formalization	ERP	Firm Size	Sales Volume
Business Performance	Pearson	1.000						
	Sig. (p)	.						
Process Efficiency	Pearson	-.079	1.000					
	Sig. (p)	.219	.					
Process Flexibility	Pearson	.397**	-.095	1.000				
	Sig. (p)	.000	.142	.				
Type of Formalization	Pearson	.254**	-.221**	.692**	1.000			
	Sig. (p)	.000	.001	.000	.			
ERP	Pearson	.757**	.085	.140*	.003	1.000		
	Sig. (p)	.000	.190	.030	.957	.		
Firm Size	Pearson	.471**	.120	.018	-.034	.561**	1.000	
	Sig. (p)	.000	.062	.782	.597	.000	.	
Sales Volume	Pearson	.418**	.115	.081	-.059	.333**	.730**	1.000
	Sig. (p)	.000	.074	.212	.365	.000	.000	.

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
N = 241.

The results presented in Table 6 show that the type of work formalization is significantly related to process efficiency, process flexibility, and business performance. Process flexibility was found to be positively related to the type of work formalization while process efficiency was negatively related to the type of work formalization. Busineess performance was positively related to the type of work formalization. ERP implementation was found significantly and positively related to business performance. Also, to test for multicollinearity, tolerance and Variance Inflation Factor (VIF) values for each predictor were calculated. All tolerances were above .10 and all VIF values were below 5. As such no variable merits further investigation from a multicollinearity perspective.

4.2. Outliers

Univariate outliers are cases that have an unusual value for a single variable. Univariate outliers analysis was performed for the following dependent variables:

- Type of Formalization
- Process Efficiency
- Process Flexibility
- Business Performance

One way to identify univariate outliers is to convert all of the scores for a variable to standard scores. Since the sample size is larger than 80 cases, a case is an outlier if its standard score is ±3.0 or beyond. Three cases had standard scores smaller than -3.0 and as such were eliminated.

Multivariate outliers are cases that have an unusual combination of values for a number of variables. The value for any of the individual variables may not be a univariate outlier, but, in combination with other variables, is a case that occurs very rarely. Multivariate outliers analysis was performed for the following set of independent variables:

- ERP Implementation
- Type of Formalization
- Process Efficiency
- Process Flexibility

Mahalanobis D2 is a multidimensional version of a z-score. It measures the distance of a case from the centroid (multidimensional mean) of a distribution, given the

covariance (multidimensional variance) of the distribution. A case is a multivariate outlier if the probability associated with its D^2 is 0.001 or less. No cases were eliminated based on the results of this analysis.

4.3. Factor Analysis

4.3.1. Type of Formalization

The form of work formalization was initially measured using four survey items rating the coercive aspect of work formalization and four survey items rating the enabling aspect of work formalization. Each item is Likert-type with a response range of 1 to 7 (1=strongly disagree and 7=strongly agree). Items A5, A6, A7, and A8 are reverse-scored.

Exploratory analysis was then performed. The results shown in the table below extracted three factors with an Eigen value of 4.82 and 60.30 percent of variance explained for factor one, an Eigen value of 1.07 and 13.40 percent of variance explained for factor two, and an Eigen value of .63 and 7.83 percent of variance for factor three. Factor loadings varied with five items loading above .80 and three items above .70. Only two items loaded higher than .90.

Table 7: Exploratory Analysis Results for Work Formalization

Work Formalization	Item	Factor 1			Factor2			Factor 3		
		Factor Loading	Eigen value	% Variance	Factor Loading	Eigen value	% Variance	Factor Loading	Eigen value	% Variance
Job Performance	A1 A2 A3 A4	0.77 0.86 0.72 0.81	4.82	60.30	0.08 0.25 0.43 0.23			0.35 0.02 0.21 0.23		
Worker Improvisation	A6 A7	0.23 0.30			0.90 0.80	1.07	13.40	0.21 0.36		
Control Orientation	A5 A8	0.17 0.36			0.25 0.49			0.90 0.76	0.63	7.83

Work formalization was subsequently examined using a confirmatory factor analysis to ensure all items fit well together, allowing us to reduce the survey items into a single composite measure. Two items, A1 and A3, were eliminated because they did not fit well in the confirmatory model. The three factors identified in the exploratory analysis were further defined in the confirmatory analysis. I contacted respondents for the qualitative validation of the Type of Formalization's three constructs. The results validated the labels used for the three constructs: Job Performance, Worker Improvisation, and Control Orientation.

Job Performance includes two survey items:

- Administrative procedures of the organization that enable employees to do their jobs.
- Managers in your organization use their authority to enable employees to do their job.

Worker Improvisation includes two survey items:

- Administrative procedures in your organization obstruct innovation.
- Administrative procedures in your organization are substitutes for professional judgment.

Control Orientation includes two survey items:

- Administrative rules in your organization are used to punish employees.
- Managers in your organization use administrative procedures to undermine employees.

The three first-order factors fit well together with a Chi Square of 10.56, a CFI and IFI of .99, an NFI of .98 and a RMSEA of .05 and with an alpha of .88 for the six retained items. Therefore, the six final item scores were averaged in order to produce a single composite work formalization score. A higher score means that work formalization is described by the respondent as mostly enabling whereas a lower score means that work formalization is described by the respondent as mostly coercive.

4.3.2. Process Flexibility

Process flexibility was initially measured using three survey items. Each item was Likert-type with the response range of 1 to 7 (1= strongly disagree, and 7= strongly agree). Exploratory analysis was then performed. The results shown in the table below extracted one factor with an Eigen value of 2.56 and 85.19 percent of variance explained. All factor loadings were above .90.

Table 8: Exploratory Analysis Results for Process Flexibility

Process Flexibility	Item	Factor Loading	Factor 1	
			Eigen value	% Variance
	B1 B2 B3	0.94 0.91 0.92	2.56	85.19

Process flexibility was subsequently examined using a confirmatory factor analysis to ensure all items fit well together, allowing us to reduce the survey items into a single composite measure. No items were eliminated because all the three first-order factors fit well in the confirmatory model. The final confirmatory model showed a good fit with a Chi Square of 3.80, a CFI and IFI of .99, an NFI of .99 and a RMSEA of .05,

and an alpha of .91. Therefore, the three item scores were averaged in order to produce a single composite process flexibility score. A higher score means higher perceived process flexibility.

4.3.3. Process Efficiency

Process efficiency was initially measured using two survey items. Each item was Likert-type with the response range of 1 to 7 (1=strongly disagree, and 7=strongly agree). Exploratory analysis was subsequently performed. The results shown in the table below extracted one factor with an Eigen value of 1.62 and 80.77 percent of variance explained. All factor loadings were above .90.

Table 9: Exploratory Analysis Results for Efficiency

Process Efficiency	**Item**	**Factor Loading**	**Factor 1**	
			Eigen value	**% Variance**
	B4 B5	0.90 0.90	1.62	80.77

Process efficiency was subsequently examined using a confirmatory factor analysis to ensure all items fit together, allowing us to reduce the survey items into a single composite measure. No items were eliminated because the two factors fit well in the confirmatory model. The final confirmatory model showed a good fit with a Chi Square of 4.50, a CFI and IFI of .99, an NFI of .99 and a RMSEA of .02, and with an alpha of .76. Therefore, the two items were averaged in order to produce a single composite process efficiency score. A higher score means higher perceived process efficiency.

4.3.4. Business Performance

Business performance was initially measured using three survey items rating perceived profitability and three survey items rating perceived sales growth. Each item was Likert-type with the response range of 1 to 7 (1= much worse, and 7= much better). Exploratory analysis was then performed. The results shown in the table below extracted one factor with an Eigen value of 4.10 and 68.35 percent of variance explained. All factor loadings were above .80.

Table 10: Exploratory Analysis Results for Business Performance

Business Performance	Item	Factor Loading	Factor 1	
			Eigen value	% Variance
	C1	0.87	4.10	68.35
	C2	0.74		
	C3	0.83		
	C4	0.81		
	C5	0.82		
	C6	0.88		

Business performance was subsequently examined using a confirmatory factor analysis to ensure all items fit well together allowing us to reduce the survey items into a single composite measure. One item, C3, was eliminated because it did not fit well in the confirmatory model. The remaining factors fit well together with a Chi Square of 6.22, a CFI and IFI of .99, an NFI of .99 and a RMSEA of .04, and with an alpha of .95. Therefore, the five final item scores were averaged in order to produce a single composite business performance score. A higher score means a higher perceived business performance.

4.4. Regression Analysis

4.4.1. Multicollinearity

Collinearity implies that two variables are near perfect linear combinations of one another. When more than two variables are involved it is often called multicollinearity. As the degree of multicollinearity increases, the regression model estimates of the coefficients become unstable and the standard errors for the coefficients can get wildly inflated.

To test for multicollinearity, tolerance and Variance Inflation Factor (VIF) values for each predictor were calculated. The "tolerance" is an indication of the percent of variance in the predictor that cannot be accounted for by the other predictors, hence very small values indicate that a predictor is redundant, and values that are less than .10 may merit further investigation. A variable with VIF values greater than 10 may merit further investigation._ All tolerances were above .10 and all VIF values were below 5.

4.4.2. Moderating Effect of Work Formalization on Process Efficiency

Regression analysis was used to assess the moderating effect of work formalization in the relationship between ERP implementation and process efficiency. An interaction term (ERP*Work_Formalization) was introduced and was entered after ERP and Work_Formalization. If adding the interaction term results in significant increase in the adjusted R^2 then the moderating effect of work formalization is confirmed.

Below are the results of the regression analysis for H1: The relationship between ERP implementation and process efficiency is moderated by the form of work formalization.

Table 11: Moderating Effect Model for Process Efficiency as Dependent Variable

Model	R	R Square	Adjusted R Square	Std Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.306[a]	0.093	0.078	1.2249	0.093	6.083	4	236	0.000
2	0.350[b]	0.123	0.104	1.2077	0.029	7.785	1	235	0.006

a. Predictors: (Constant), Work_Formalization, ERP, Employees, Sales
b. Predictors: (Constant), Work_Formalization, ERP, Employees, Sales, Work_Formalization*ERP
c. Dependent Variable: Process_Efficiency

Under Change Statistics, we see that the adjusted R Square Change is 0.026 when the interaction variable is added to the predictor and moderator variables in model 2. This change is significant, F(1,235)=7.785, p=0.006. The significant interaction tells us that our presumed moderator (Work Formalization) does indeed moderate the effects of the predictor (ERP Implementation) on the outcome variable (Process Efficiency).

In order to see whether the significant moderator effect is in the predicted direction, multiple regression analysis was performed to test the effects ERP implementation, Work Formalization, and their interaction on Process Efficiency. Below are the regression equations being tested. Table 11 summarizes the results of this analysis.

(3.4.1) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3$

(3.4.2) $Y_1 = B_0 + B_1X_4 + B_2X_2 + B_3X_3$

(3.4.3) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$

(3.4.4) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_1X_4$

Y_1 = *process efficiency,*

X_1 = *ERP Implementation,*

X_2 = *firm size,*

X_3 = *sales volume,*

X_4 = *type of formalization,*

and the B's are the parameter estimates.

Table 12: Moderating Effect Regression Analysis Results for Process Efficiency as Dependent Variable

Dependent Variable: Process Efficiency Beta Coefficients	**Control Model**	**3.4.1**	**3.4.2**	**3.4.3**	**3.4.4**
Control Variables					
Firm Size	0.061 (0.074)	0.178* (0.084)	0.068 (0.072)	0.178* (0.082)	0.198* (0.081)
Sales Volume	0.041 (0.066)	0.016 (0.066)	0.030 (0.065)	0.006 (0.065)	0.022 (0.064)
Independent Variables					
ERP Implementation		0.573** (0.202)		0.559** (0.197)	1.467† (0.752)
Type of Formalization			-0.220** (0.064)	- 0.216** (0.063)	- 0.725** (0.193)
ERP x Type of Formalization					0.406** (0.146)
Model Fit					
Adjusted R^2	0.008	0.036	0.051	0.078	0.104
F Value	1.942	4.028 **	5.276 **	6.083 **	6.563 **
Incremental R^2		0.032 ^{A}	0.047 ^{A}	0.044 ^{B}	0.011 ^{C}
Incremental F		2.086 ^{A}	3.334 ^{A}	2.055 ^{B}	0.480 ^{C}

† $p < 0.1$.
* $p < 0.05$.
** $p < 0.01$.
^{A} Incremental compared to the control model.
^{B} Incremental compared to 3.4.1.
^{C} Incremental compared to 3.4.3.

The results presented in Table 11 indicate that after controlling for the control variables, ERP implementation was positively related to process efficiency ($p<0.01$) and the overall model was significant ($p<0.01$). The incremental adjusted R^2 over the control model was significant ($p<0.01$), with ERP implementation improving over on the total explained variation in process efficiency from 0.8% adjusted R^2 in the control model to 3.6% adjusted R^2 in the ERP implementation model (3.4.1). The results also indicate that after controlling for the control variables, the type of work formalization was negatively related to process efficiency ($p<0.01$) and the overall model was also significant

($p<0.01$). The incremental F value of the work formalization model (3.4.2) over the control model was also significant ($p<0.01$), with the type of work formalization increasing the total explained variance in process efficiency from 1.6% in the control model to 5.1% adjusted R^2.

While the ERP implementation and the work formalization models focus on the main effects of ERP implementation and work formalization on process efficiency as two separate explanatory variables, model 3.4.3 focuses on the effect of work formalization on process efficiency over and above that of ERP implementation. The results presented in Table 11 indicate that after controlling for control variables, the type of work formalization was negatively related to process efficiency ($p<0.01$) and ERP implementation was still positively related to process efficiency ($p<0.01$) and the overall model was significant ($p<0.01$). This indicates that adding the type of work formalization into the model does not weaken the explanatory power of ERP implementation. The incremental adjusted R^2 of the combined effect model (3.4.3) was significant with an adjusted R^2 at 7.8%.

Finally the interaction model (3.4.4) focuses on the interaction effect of ERP implementation and the type of work formalization on process efficiency. The results shown in Table 11 indicate that when adding the interaction term between ERP implementation and the type of work formalization to the interaction model, which already has both ERP implementation and the type of work formalization as two independent variables, the interaction term was significant ($p<0.01$) and positively related to process efficiency and the overall model was significant ($p<0.01$). ERP implementation was still positively related to process efficiency ($p<0.05$). The type of

work formalization was still significantly related to process efficiency ($p<0.01$). In addition, the incremental adjusted R^2 of the interaction model (3.4.4) over the combined model (3.4.3) was significant ($p<0.01$) and improved the total explained variation in process efficiency to 10.4%.

The results above support Hypothesis 1 as the relationship between ERP implementation and process efficiency appears to be moderated by the form of work formalization. Specifically, the results support the positive direction of the moderating effect the form of work formalization on the relationship between ERP implementation and process efficiency and as such H1a and H1b are supported.

4.4.3. Moderating Effect of Work Formalization on Process Flexibility

The moderating effect or work formalization was tested by introducing an interaction term (ERP*Work_Formalization) and entering it after ERP and Work_Formalization. If adding the interaction term results in significant increase in the adjusted R^2 then the moderating effect of work formalization is confirmed.

Below are the results of the regression analysis for H2: The relationship between ERP implementation and process flexibility is moderated by the form of work formalization.

Table 13: Moderating Effect Model for the Process Flexibility as Dependent Variable

Model	R	R Square	Adjusted R Square	Std Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.723[a]	0.523	0.515	1.0580	0.523	64.679	4	236	0.000
2	0.741[b]	0.550	0.540	1.0300	0.027	14.010	1	235	0.000

a. Predictors: (Constant), Work_Formalization, ERP, Employees, Sales
b. Predictors: (Constant), Work_Formalization, ERP, Employees, Sales, Work_Formalization*ERP
c. Dependent Variable: Process_Flexibility

Under Change Statistics, we see that the adjusted R Square Change is 0.025 when the interaction variable is added to the predictor and moderator variables in model 2. This change is significant, $F(1,235)=13.602$, $p<0.01$. The significant interaction tells us that our presumed moderator (Work Formalization) does indeed moderate the effects of the predictor (ERP Implementation) on the outcome variable (Process Flexibility).

In order to see whether the significant moderator effect is in the predicted direction, multiple regression analysis was performed to test the effects ERP implementation, Work Formalization, and their interaction on Process Flexibility.

(3.4.5) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3$

(3.4.6) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_4$

(3.4.7) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4$

(3.4.8) $Y_1 = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_1X_4$

Y_1 = process flexibility,

X_1 = ERP Implementation,

X_2 = firm size,

X_3 = sales volume,

X_4 = type of formalization,

and the B's are the parameter estimates.

Table 14: Moderating Effect Regression Analysis Results for Process Flexibility as Dependent Variable

Dependent Variable: Process Flexibility Beta Coefficients	**Control Model**	**3.4.5**	**3.4.6**	**3.4.7**	**3.4.8**
Control Variables					
Firm Size	- 0.082 (0.088)	- 0.215* (0.100)	- 0.093 (0.063)	- 0.216** (0.071)	- 0.193** (0.069)
Sales Volume	0.121 (0.079)	0.150† (0.079)	0.164** (0.057)	0.190** (0.056)	0.209** (0.055)
Independent Variables					
ERP Implementation		0.650** (0.241)		0.595** (0.170)	2.913** (0.641)
Type of Formalization			0.847** (0.056)	0.843** (0.055)	0.261 (0.164)
ERP x Type of Formalization					0.465** (0.124)
Model Fit					
Adjusted R^2	0.002	0.027	0.492	0.515	0.540
F Value	1.214	3.251*	78.474**	64.679**	65.397**
Incremental R^2		0.030^{A}	0.398^{A}	0.483^{B}	0.027^{C}
Incremental F		2.037^{A}	77.260^{A}	61.428^{B}	0.718^{C}

† $p < 0.1$.
* $p < 0.05$.
** $p < 0.01$.
^{A} Incremental compared to the control model.
^{B} Incremental compared to 3.4.5.
^{C} Incremental compared to 3.4.7.

The results presented in Table 13 indicate that after controlling for the control variables, ERP implementation was positively related to process flexibility ($p<0.01$) and the overall model was significant ($p<0.05$). The incremental adjusted R^2 over the control model was significant ($p<0.05$), with ERP implementation improving over on the total explained variation in process flexibility from 0.2% adjusted R^2 in the control model to 2.7% R^2 in the ERP implementation model (3.4.5). The results also indicate that after controlling for the control variables, the type of work formalization was positively related to process efficiency ($p<0.01$) and the overall model was also significant ($p<0.01$). The incremental adjusted R^2 of the work formalization model (3.4.6) over the control model was also significant ($p<0.01$), with the type of work formalization increasing the total explained variance in process efficiency from 0.2% in the control model to 49.2% adjusted R^2.

While the ERP implementation and the work formalization models focus on the main effects of ERP implementation and work formalization on process flexibility as two

separate explanatory variables, model 3.4.7 focuses on the effect of work formalization on process flexibility over and above that of ERP implementation. The results presented in Table 13 indicate that after controlling for control variables, the type of work formalization was positively related to process flexibility ($p<0.01$) and ERP implementation was positively related to process efficiency ($p<0.01$) and the overall model was significant ($p<0.01$). This indicates that adding the type of work formalization into the model does not weaken the explanatory power of ERP implementation. The incremental adjusted R^2 of the combined effect model (3.4.7) was significant with an R^2 at 51.5%, an increase of 48.8% compared to the ERP implementation model (3.4.6).

Finally the interaction model (3.4.8) focuses on the interaction effect of ERP implementation and the type of work formalization on process flexibility. The results shown in Table 13 indicate that when adding the interaction term between ERP implementation and the type of work formalization to the interaction model, which already has both ERP implementation and the type of work formalization as two independent variables, the interaction term was significant ($p<0.01$) and positively related to process flexibility and the overall model was significant ($p<0.01$). While ERP implementation was still positively related to process flexibility ($p<0.01$), the type of work formalization was no longer significantly related to process flexibility. It appears that in the interaction model, the effect of the type of work formalization as independent variable was subsumed by the positive effect of ERP implementation and the interaction term. In addition, the incremental adjusted R^2 of the interaction model (3.4.8) over the combined model (3.4.7) was significant ($p<0.01$) and improved the total explained variation in process flexibility to 54.0%.

The results above support Hypothesis 2 as the relationship between ERP implementation and process flexibility appears to be moderated by the form of work formalization. Specifically, the results support the positive direction of the moderating effect the form of work formalization on the relationship between ERP implementation and process flexibility and as such H2a and H2b are supported.

4.4.4. Mediating Effect of Process Efficiency

Regression analysis was performed to test the mediating effect of the operational enablers of dynamic capabilities. Transformed data was used for the regressions. To determine the relationship between two variables through regression analysis, the average scores of the mediating variable (e.g., ***operational enablers of dynamic capabilities***) was related on a factor with the average scores of the dependent variable [e.g., ***business performance***].

Process efficiency is hypothesized to be positively related to business performance (H3). Below is the regression equation testing this hypothesis and the results of the regression analysis.

(3.4.9) $Y = B_0 + B_1M + B_2X_2 + B_3X_3$

Y = business performance,

X_2 *= firm size,*

X_3 *= sales volume,*

M = process efficiency,

and the B's are the parameter estimates.

Table 15: Direct Effect of Process Efficiency on Business Performance

Dependent Variable: Business Performance	**3.4.9**
Beta Coefficients	
Firm Size	0.230 (0.052)***
Sales Volume	0.094 (0.046)**
Process Efficiency	-0.114 (0.045)**
Model Fit	
Adjusted R^2	0.245
F Value	26.920***
Critical F Value	2.643

* p < 0.1
** p < 0.05
*** p < 0.01

The results presented in Table 14 indicate that after controlling for the control variables, process efficiency was negatively related to business performance ($p<0.05$) and the overall model was significant ($p<0.01$). The overall R^2 of the model was significant ($p<0.05$), with 24.5% of total variation in business performance explained by process efficiency. The results therefore do not provide support for H3. Process efficiency is negatively related to business performance.

According to Baron and Kenny (1986), three conditions must hold to establish mediation. First, ERP implementation must affect the operational enablers of dynamic capabilities. Second, ERP implementation must be shown to affect business performance. Third, operational enablers of dynamic capabilities must affect business performance controlling for ERP implementation. If all these conditions hold in the predicted direction, then the effect of ERP implementation on business performance must be less in the third set of equations than in the second set of equations to confirm the mediating effect of operational enablers of dynamic capabilities.

Since the main relationship between the independent and dependent variables was not supported in the hypothesized direction then the mediating effect of process efficiency in the relationship between ERP implementation and business performance (H5) is not supported.

4.4.5. Mediating Effect of Process Flexibility

Regression analysis was performed to test the mediating effect of process flexibility. Transformed data was used for the regressions. To determine the relationship between two variables through regression analysis, the average scores process flexibility was related on a factor with the average scores of business performance.

Process flexibility is hypothesized to be positively related to business performance (H4). Below is the regression equation testing this hypothesis and the results of the regression analysis.

(3.4.10) $Y = B_0 + B_1M + B_2X_2 + B_3X_3$

Y = business performance,

X_2 *= firm size,*

X_3 *= sales volume,*

M = process flexibility,

and the B's are the parameter estimates.

Table 16: Direct Effect of Process Flexibility on Business Performance

Dependent Variable: Business Performance	**3.4.10**
Beta Coefficients	
Firm Size	0.244 (0.047)***
Sales Volume	0.059 (0.042)
Process Flexibility	0.256 (0.035)***
Model Fit	
Adjusted R^2	0.370
F Value	47.999***
Critical F Value	2.643

* p < 0.1
** p < 0.05
*** p < 0.01

The results presented in Table 15 indicate that after controlling for the control variables, process flexibility was positively related to business performance ($p<0.01$) and the overall model was significant ($p<0.01$). The overall R^2 of the model was significant ($p<0.01$), with 37.0% of total variation in business performance explained by process flexibility. The results therefore provide support for H4. Process flexibility is positively related to business performance.

According to Baron and Kenny (1986), three conditions must hold to establish mediation. First, ERP implementation must affect the operational enablers of dynamic capabilities (3.4.5). Second, ERP implementation must be shown to affect business performance. Third, operational enablers of dynamic capabilities must affect business performance controlling for ERP implementation. If all these conditions hold in the predicted direction, then the effect of ERP implementation on business performance must be less in the third set of equations than in the second set of equations to confirm the mediating effect of operational enablers of dynamic capabilities.

The regression equations and the standardized coefficients (betas) and adjusted coefficients of determination (R^2) are shown below. The significance of the hypothesized relationships was tested using F-statistic, with relationships considered significant when $p<0.05$. The significance of the hypotheses was tested using t-statistic, with beta coefficients considered significantly different from zero when $|t| > 1.96$ ($p < 0.05$).

(3.4.11) $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3$

(3.4.12) $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4M$

Y = business performance,

X_1 = ERP implementation,

X_2 = firm size,

X_3 = sales volume,

M = process flexibility, and the B's are the parameter estimates.

Table 17: Process Flexibility Mediating Effect Regression Analysis Results

Dependent Variable: Business Performance	**3.4.5**	**3.4.11**	**3.4.12**
Beta Coefficients			
Firm Size		-0.098 (0.043)**	-0.057 (0.039)
Sales Volume		0.159 (0.034)***	0.130 (0.030)***
Process Flexibility			0.190 (0.025)***
ERP Implementation		1.567 (0.103)***	1.443 (0.094)***
Dependent Variable: Process Flexibility			
Beta Coefficients			
Firm Size	-0.215 (0.100)*		
Sales Volume	0.150 (0.079)*		
ERP Implementation	0.650 (0.241)**		
Model Fit			
R^2	0.027	0.608	0.685
F Value	3.251**	125.113***	131.236***
Critical F Value	2.643	2.643	2.410

* $p < 0.1$
** $p < 0.05$
*** $p < 0.01$

The results show that ERP implementation significantly affects process flexibility ($F=3.251$ and $p<0.01$ (3.4.5)). ERP implementation is also shown to significantly affect business performance ($F=125.113$ and $p<0.01$ (3.4.11)). Finally, process flexibility significantly affects business performance controlling for ERP implementation ($F=131.236$ and $p<0.01$ (3.4.12)). The three conditions hold in the predicted direction and the effect of ERP implementation on business performance is less in the third model than in the second model. According to Baron and Kenny (1986), the results above confirm the mediating effect of process flexibility. H6 is therefore supported. The significant coefficent for ERP implementation indicates a partially mediated model with a direct path from ERP implementation to business performance.

Chapter 5: Summary of Findings and Conclusions

This final chapter summarizes the empirical results of this study and draws conclusions regarding the theoretical, methodological, and managerial implications of this research. It also highlights some limitations of this study and the effort performed to mitigate them. Finally this chapter highlights some avenues for future research.

5.1. Conclusions and Discussion

This research was an attempt to define a pathway through which ERP implementation may lead to higher business performance by examining work formalization as a contingency factor boosting organizational enablers of dynamic capabilities, which in turn, enhance business performance in the context of ERP implementations. ERP pathways to dynamic capabilities and business performance were approached using the distinction between the enabling and disabling forms of work formalization as characteristics of the conditions under which ERP is implemented. This definition was tested by asking 500 managers at companies using ERP systems matched with a control group based on industry and size to rate their organization's current work formalization, process efficiency, process flexibility, and business performance. Based on the results of this study, the enabling aspect of work formalization was found to significantly boost process performance and process flexibility for ERP adopters. The boosted process flexibility seemed to in turn significantly enhance business performance in the context of ERP implementations. Process efficiency however was not found to

significantly lead to higher business performance. Table 17 provides a summary of hypotheses testing.

Table 18: Results of Hypotheses Testing

Hypotheses	**Results**
Hypothesis 1: The relationship between ERP implementation and process efficiency is moderated by the form of work formalization.	• Supported (there is a significant difference in the predicted direction)
Hypothesis 2: The relationship between ERP implementation and process flexibility is moderated by the form of work formalization.	• Supported (there is a significant difference in the predicted direction)
Hypothesis 3: Process efficiency is positively related to business performance.	• Not supported (there is a significant relationship in the opposite direction)
Hypothesis 4: Process flexibility is positively related to business performance.	• Supported (there is a significant relationship in the predicted direction)
Hypothesis 5: The relationship between ERP implementation and business performance is mediated by process efficiency.	• Not supported (there is a significant relationship in the opposite direction)
Hypothesis 6: The relationship between ERP implementation and business performance is mediated by process flexibility.	• Supported (there is a significant mediation)

The first research question in this study rested up on the logic of contingency perspective to examine the moderating effect of the form of work formalization on the relationship between ERP implementation, and process flexibility and process efficiency as operational enablers of dynamic capabilities.The enabling form of work formalization was found to significantly boost the impact of ERP implementation of process efficiency and process flexibility. Regression analysis results showed that adding the interaction term of work formalization and process efficiency led to a significant increase in model

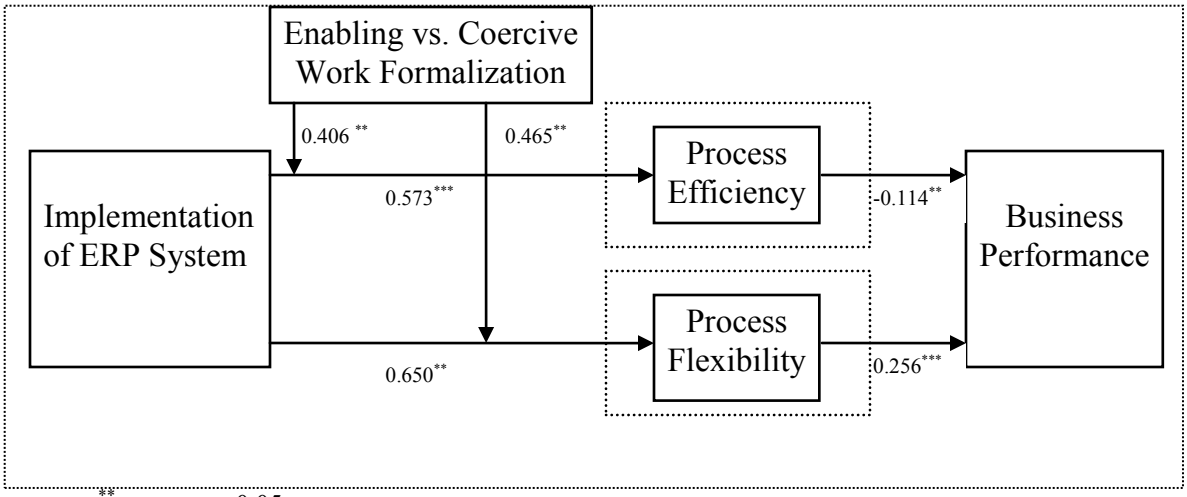
fit with a significant moderating effect in the predicted direction. Similarly, adding the interaction term of work formalization and process flexibility led to a significant increase in model fit with a significant moderating effect in the predicted direction.

The second research question was based on the RBV logic and investigates the mediating effect of operational enablers of dynamic capabilities, i.e., process flexibility and process efficiency, on the relationship between ERP implementation and business performance. The study produced mixed results regarding the mediating effect of the operational enablers of dynamic capabilities, i.e., process efficiency and process flexibility. Regression analysis results showed that ERP implementation significantly enhances process flexibility. ERP implementation was also shown to significantly boost business performance. Finally, process flexibility significantly improved business performance controlling for ERP implementation. The three conditions held in the predicted direction and the effect of ERP implementation on business performance was less in the third model than in the second model. Therefore, process flexibility was mediating the positive impact of ERP implementation on business performance.

On the other hand, process efficiency did not appear to significantly improve business performance. Process efficiency was shown to negatively impact perceived business performance. As such the mediating effect of process efficiency in the relationship between ERP implementation and business performance was not supported. The negative relationship between process efficiency and business performance was not consistent with the reviewed literature. Perhaps the explanation for this finding from a methodological perspective is that process efficiency is positively related to the absolute business performance and not the perceived business performance as compared to the

most direct competitor, prior years' performance, and the goals and objectives set by top management. From a theoretical perspective, the Balance Scorecard approach may also help explain this unexpected relationship between process efficiency and business performance. Fang (2006) argues that ERP adopters should focus simultaneously on financial, customer, internal process, and innovation and learning factors including the integration requiremrnts of future developments to guarantee higher levels of performance. If an aspect of operational performance such as process efficiency is taken to the extreme without the balancing act of the other aspects of operational performance, this may negatively impact the overall business performance in the longer term.

In summary, this research presented empirical evidence that ERP implementation is positively related to business performance only if accompanied with enabling work formalization and a strategic focus on promoting process flexibility rather than process efficiency. The positive impact of ERP implementation on operational enablers of dynamic capabilities, i.e. process efficiency and process flexibility, was significantly boosted by the enabling form of work formalization. Process flexibility was in turn shown to enhance business performance while process efficiency was shown to hinder business performance. Figure 10 provides a summary of the results of hypothesized effects.



** p < 0.05
*** p < 0.01

Figure 10: Results of Hypothesized Effects

5.2. Theoretical and Methodological Implications

The ERP context is becoming a mainstream part of corporate life. The continuous phenomenal ERP invasion of the corporate world keeps feeding managers and researchers' interest in understanding the ultimate impact of ERP implementations. However, the reported high profile failures of ERP implementations have long been a key driver of the anxiety about the actual benefits of such large IT investments. Noting that most ERP studies had been embryonic or still at the exploratory stage, researchers have recently initiated a wave of academic attempts to examine this phenomenon using a more systematic approach. This effort has revealed the existence of pathways through which ERP systems may lead to higher business performance after the implementation is completed. This study further investigated the characteristics of these pathways by examining work formalization as a contingency factor boosting organizational enablers of dynamic capabilities, which in turn enhance business performance in the context of ERP implementations. ERP pathways to dynamic capabilities and business performance were

approached using the distinction between enabling and disabling forms of work formalization as characteristics of the conditions under which ERP is implemented.

In a broader spectrum, this study used ERP systems as an example of an IT innovation to further explore the complex relationship between IT innovation and economic and operational performance. The success of innovating with IT hinges on the business ability to adopt and assimilate (Swanson, 2005). We contended that this ability is developed through the modification of the operational performance of business processes. Operational improvements during the post-implementation period were shown to be driven by process flexibility, which is a key antecedent of the dynamic capability at the operational level. We also identified work formalization as an organizational attribute impacting the business ability to adopt and assimilate an ERP implementation as an IT innovation. Highly formalized work appeared to hinder the positive impact of ERP systems on process flexibility, thus potentially hindering operational performance. As such, organizations with enabling work formalization may face lower barriers to assimilate the new processes.

These findings are in line with Masini's (2003) findings. Masini has argued that changes in key performance indicators are best explained by the modification of the constituents of the dynamic capability construct at the operational level as a result of Enterprise Systems implementation. However, this study only confirmed the mediating effect of process flexibility as an operational enabler of dynamic capability. Also, Masini highlighted the fact that organizational rigidity has a negative impact on performance in the context of an ERP implementation. Similarly, the results in this research suggest that the disabling form of work formalization hinders business performance in the context of

an ERP implementation.

This research also attempted to integrate the literature on the IT productivity paradox and bridges the gap between systems-oriented and concept-oriented approaches to IT innovation. The framework combined both the contingency theory perspective and the resource-based view perspective in an attempt to identify the organizational processes generating operational improvements with IT innovations. Instead of adopting a purely econometric approach, this study looked at the intermediate process-level variables linking IT investments to business performance from a strategic and organizational angle.

In addition, this study subjected the widely criticized paradigm of dynamic capabilities to empirical testing. Since Leonard-Barton came up with the concept of dynamic capabilities in 1992, this concept has been mainly described as a theoretical concept that received very little empirical verification (Masini, 2003). This study identified a set of specific measures to empirically test this concept at the operational level.

Finally, this study used a more rigorous methodological approach to study business performance, operational enablers of dynamic capabilities, and work formalization. As shown in Table 18, the previous studies that validated the scales used in this research only used exploratory factor analysis. This study combined both exploratory and confirmatory factor analysis, and the resultant scales were more streamlined.

Table 19: Comparison of Validity and Reliability to Previous Studies

Variables	Original Studies		Pre-Test	Current Study		
	EFA	Cronbach Alpha	Cronbach Alpha	EFA	CFA	Cronbach Alpha
Work Formalization *Sweetland (2001) McGuigan (2005)*	.40 to .81	> .90	.89	.72 to .90	Chi Square 10.56 CFI and IFI .99 NFI .98 RMSEA .05	.88
Process Efficiency *Masini (2003)*	.85 to .89	.70	.80	.90	Chi Square 4.50 CFI and IFI .99 NFI .99 RMSEA .02	.76
Process Flexibility *Masini (2003)*	.68 to .89	.70	.91	.91 to .94	Chi Square 3.80 CFI and IFI .99 NFI .99 RMSEA .05	.91
Business Performance *Dooms et al. (2005)*	Not Available	.86	.97	.74 to.88	Chi Square 6.22 CFI and IFI .99 NFI .99 RMSEA .04	.95

The methodological approach used in this study resulted in scales with fewer items, yet the scales for most part achieved stronger factor loadings and higher Cronbach alphas (i.e., more valid and reliable) than those in previous studies. The examination of work formalization using confirmatory factor analysis allowed us to reduce the survey scale to six items, making up a single composite measure. Two items, A1 and A3, were eliminated because they did not fit well in the confirmatory model. The three factors identified in the exploratory analysis were further defined in the confirmatory analysis. The three factors were qualitatively validated resulting in three three constructs: Job Performance, Worker Improvisation, and Control Orientation. Similarly, Business performance was examined using a confirmatory factor analysis to ensure all items fit well together allowing us to reduce the survey scale to five items, making up a single composite measure. One item, C3, was eliminated because it did not fit well in the confirmatory model. Therefore, this study not only make the theoretical contributions to

the systems-oriented and concept-oriented approaches to IT innovation as previously discussed, but also makes a methodological contribution to this stream of research through the use of a more rigorous methological approach with more steamlined and reliable measurement scales.

5.3. Managerial Implications

The results of this empirical study provide ERP adopters and software vendors with a This study points out that the mere implementation of ERP systems without creating the appropriate conditions to develop ERP-generated capabilities does not necessarily enhance business performance. This study reinforces the findings of previous studies such as Davenport (2004) who came to the conclusion that the mere assembly of raw technical components of a vision can only yield to a limited amount of value. Davenport found that substantial benefits are realized only when an organization creatively takes the raw components, claims them as its own and directs them to meet its unique business vision. The results of this study specifically highlight a pathway that enhances the impact of ERP implementation on business performance. They show that the type of work formalization, i.e. enabling vs. disabling work formalization, moderates the impact of ERP implementation on process flexibility. Process flexibility was in turn shown to enhance business performance.

This study clearly identifies the enabling form of work formalization and process flexibility as some of the key factors impacting the success of ERP systems. This will help ERP implementers and adopters better define their implementation strategies. These strategies should stay away from configuring new ERP systems in a way that focuses

solely on process efficiency and reduces process flexibility. As figure 10 showed, ERP implementations are positively related to business performance only if accompanied with enabling work formalization and a strategic focus on promoting process flexibility rather than process efficiency. Process flexibility would leave some room for the process owners to use their creativity and knowledge of the new system to continuously adapt the process to the functionality offered by the new system. This would help ERP adopting organizations achieve enhanced business performance and lead the way in defining best practices.

The findings of this study also shed some light on the importance of some aspects of organizational reengineering. Vendors may use the findings to revisit the consulting services they offer and the project implementation plans they recommend to companies implementing ERP systems. The consulting services offered to ERP adopting firms should emphasize the importance of identifying the various options available to them based on the ERP functionality instead of forcing the firms to follow a pre-defined business process model reducing process flexibility and leaning towards a rigid and disabling form of work formalization. Also, the implementation plans recommended to companies implementing ERP should emphasize the importance of thoroughly analyzing all pre-implementation business processes as compared to the ERP system functionality. This analysis would help identify the gaps and the various options available to the ERP adopting organization. Business process decisions should be documented in a way to explain the rationale behind the adopted configuration but also to identify the various options still available for future process enhancements. This would potentially create an environment characterized by enabling form of work formalization and flexible business

processes capable of adapting to the dynamics of the organization and its environment, thus enhancing business performance.

5.4. Limitations of the Study and Future Research

There are several limitations to this study. The present study asked for responses from fixed format, set-questions survey tools, which could direct questions to the exclusion of providing additional input. A website survey data collection methods may contribute to a low response rate or response error. Some favorable techniques such as sending a cover letter, providing a deadline for returning the survey, and promising anonymity were applied in order to increase the response rate. Maturation of participants may also affect the survey response rate. Maturation of participants, in the context of my research, means that some of the respondents may quit their job or get transferred to another location. However, a short study period was chosen to limit any negative effects from maturation.

Only a survey research design was used in this research. In-depth interviews or personal observations require permission from head offices which may be located in other parts of the country or the world. In order to simplify the data collection process, interviews and personal observations were not considered in the research design.

The generalizability of this research is also suspect. The mix of companies participating in this research may not necessarily be reflective of the actual use of ERP systems. Also, the respondents within those companies may not accurately represent the organization's true perceptions regarding work formalization, process efficiency, process flexibility, and business performance. Finally, the motivation of the individuals participating in this survey has the potential to create individual response bias.

These limitations were mitigated by taking the following measures in order to develop a manner of generalization. Subjects were randomly selected from members of the Association for Operations Management (APICS), the Association for Information Technology Professionals (AITP), and the Association of Chartered Accountants in the United States (ACAUS). To identify firms using ERP systems, the public customer databases published on major ERP vendors' websites, ERP user-groups companies, and ERP consultants' clients were used. Each ERP-adopting firm was matched with a control group firm based on size, industry, and financial variables. Firms were matched by the four-digit Standard Industrial Classification (SIC) code then matched by size, using total annual sales and number of employees. Also, all the subjects were assured that their names would not be disclosed and confidentiality would be assured. In addition, all the managers were requested not to disclose their name on the questionnaire. Since the research was based on the survey questionnaire, the respondents (managers) were not forced to respond to each specific question.

Several questions remain unanswered and deserve further investigation. First, this study is restricted to the operational and business performance impact of ERP implementation. The impact of these complex systems on sustained competitive advantage was not addressed. Other cultural and behavioral forces may have an antithetical effect.

Second, the data for this study comes from US companies. Another approach would be to expand the scope study to include other countries. This broadened scope would shed some light on the interplay of culture and ERP. Specifically, further research would attempt to answer the question of how the culture of a country and the culture

within an organization affect the pathways through which ERP systems may lead to higher business performance after the implementation is completed.

Finally, the unexpected finding that process efficiency is negatively related to business performance indicates the need for additional research to approach business performance as an absolute organizational measure instead of a perceived measure compared to the most direct competitor, prior years' performance, and the goals and objectives set by top management. Longitudinal studies exploring the long term impact of ERP systems may also help better understand the impact of ERP systems' maturity on the relationship between ERP implementation, process efficiency, and business performance. Additional research exploring the Balanced Scorecard approach is also needed. More studies need to verify if the unbalanced focus on some aspects of operational performance may impact the relationship between ERP implementation, process efficiency, and business performance. Adopting a Balanced Scorecard approach would identify all financial and non-financial factors relevant to measuring performance in the ERP context.

In summary, this research has identified the need for studies adopting a more systematic approach to examine the pathways through which ERP systems may lead to higher process and business performance after the implementation is completed. Sound theories and empirical studies further examining the conditions under which ERP boosts dynamic capabilities and enhances business performance are needed to appease the long lived researchers and decision makers' anxiety about the high failure risk and costs associated with ERP.

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Appendix A - Employee Consent Letter

[Date]

Dear Sir/Madam,

I am (Reda Bernoussi, doctoral candidate from the department of management at TUI University) working on a research project entitled "Work Formalization, Dynamic Capabilities, and Business Performance in the Context of Enterprise Resource Planning." You are asked to participate in this survey research project. You were selected as a possible participant in this study because the research is being conducted on --------- and you work for the same industry.

Individuals who respond to the survey will not be identified. Only aggregate statistics are needed to help organizations understand the interaction between the type of work formalization and organizational performance. Raw responses will not be accessed or otherwise transmitted to any of the organizations. Also please note that the research is not being funded or otherwise sponsored by any of the organizations. Only the results of the study may be used by the corporations.

Your participation is voluntary and you may refuse to complete a survey without consequences of any kind. By completing the survey, you have consented to participate in the study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Participation or non-participation will not effect your personal consideration or right you usually expect. You may also refuse to answer any questions you do not want to answer and still remain in the study.

If you have questions regarding your rights as a research subject, contact the Institutional Review Board for the Protection of Human Subjects at TUI University (formerly Touro University International), 5665 Plaza Drive, 3rd Floor, Cypress, California 90630; Telephone: (714) 226-9840, extension 2004 or email to Dr. Afshin Afrookhteh (aafrookhteh@tuiu.edu).

Results of the survey will be provided to you upon request. If you would like to see a summary of the results, please call me at 972-248-8553. Or contact me via email: rbernoussi@tuiu.edu.

Please follow the instructions for completing the attached survey. After completing the survey, please tear off and keep this cover page with my contact information. Please fold the remaining two pages of the survey in half, seal your answers in the attached envelope, and return it to me no later than June 30, 2010.

Your contribution to the research project is greatly appreciated.

Reda Bernoussi

Appendix B - Employee survey Questionnaire

Section A: Type of Formalization

The following statements are descriptions of the administrative rules and procedures in your organization. Please indicate the extent to which each statement characterizes behavior in your organization.
(1 = strongly disagree, 2 = mostly disagree, 3 = somewhat disagree, 4 = neither disagree nor agree, 5 = somewhat agree, 6 = mostly agree, and 7 = strongly agree).

(Enabling Bureaucracy)										***Sources***
A1. Administrative procedures in your organization enable authentic communication between managers and employees.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	Sweetland, 2001; McGuigan, 2005 (wording modified: added "between managers and employees")
A2. Administrative procedures in your organization enable employees to do their job.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	Sweetland, 2001; McGuigan, 2005 (wording modified: added "employees")
A3. Administrative rules in your organization are guide to solutions rather than rigid procedures.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	Sweetland, 2001; McGuigan, 2005 (wording modified: added "in your organization")
A4. Managers in your organization use their authority to enable employees to do their job.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	Sweetland, 2001; McGuigan, 2005 (wording modified: added "manager" and "employees")
(Coercive Bureaucracy) Use reverse coding										***Sources***
A5. Administrative rules in your organization are used to punish employees.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	Sweetland, 2001; McGuigan, 2005 (wording modified: added "in your organization")
A6. Administrative procedures in your organization obstruct innovation.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	Sweetland, 2001; McGuigan, 2005 (wording modified: added "in your organization")
A7. Administrative procedures in your organization are substitutes for professional judgment.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	Sweetland, 2001; McGuigan, 2005 (wording modified: added "in your organization")
A8. Managers in your organization use administrative procedures to undermine employees.	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	Sweetland, 2001; McGuigan, 2005 (wording modified: added "manager" and "employees")

Section B: Operational Antecedents of Dynamic Capabilities

How would you rate your organization's most current capabilities in terms of the parameters below?

(Process Flexibility) (1 = extremely poor 2 = mostly poor, 3 = somewhat poor, 4 = neither good nor poor, 5 = somewhat good, 6 = mostly good, and 7 = Excellent).										***Sources***
B1. Ability of your organization to deal with unexpected events.	Extremely Poor	1	2	3	4	5	6	7	Excellent	Masini, 2003
B2. Ability of your organization to reallocate resources across functions.	Extremely Poor	1	2	3	4	5	6	7	Excellent	Masini, 2003
B3. Ability of your organization to modify processes.	Extremely Poor	1	2	3	4	5	6	7	Excellent	Masini, 2003
(Process Efficiency) (1 = very 2 = mostly little, 3 = somewhat little, 4 = neither little nor large, 5 = somewhat large, 6 = mostly large, and 7 = Very Large).										***Sources***
B4. Amount of time necessary to execute tasks.	Very Limited	1	2	3	4	5	6	7	Very Large	Masini, 2003
B5. Amount of resources necessary to execute tasks.	Very Limited	1	2	3	4	5	6	7	Very Large	Masini, 2003

Section C: Business Performance

Please rate your organization's average performance as measured by profitability and sales growth over the last two years compared to each benchmark:
(1 = much worse, 2 = mostly worse, 3 = somewhat worse, 4 = neither better nor worse, 5 = somewhat better, 6 = mostly better, and 7 = Much better).

Benchmarks Average performance compared to:	**Profitability**									**Sources**
C1. Performance of the most direct competitor.	Much Worse	1	2	3	4	5	6	7	Much Better	Dooms et al., 2005
C2. Performance of your organization in previous years.	Much Worse	1	2	3	4	5	6	7	Much Better	Dooms et al., 2005
C3. Goals & Objectives set by top management	Much Worse	1	2	3	4	5	6	7	Much Better	Dooms et al., 2005 (In lieu of "Expectations of Headquarters")
Benchmarks Average performance compared to:	**Sales Growth**									
C4. Performance of the most direct competitor.	Much Worse	1	2	3	4	5	6	7	Much Better	Dooms et al., 2005
C5. Performance of your organization in previous years.	Much Worse	1	2	3	4	5	6	7	Much Better	Dooms et al., 2005
C6. Goals & Objectives set by top management	Much Worse	1	2	3	4	5	6	7	Much Better	Dooms et al., 2005 (In lieu of "Expectations of Headquarters")

Section D: Enterprise Resource Planning Implementation

D1. Did your organization implement an Enterprise Resource Planning system (Oracle, PeopleSoft, SAP, etc.) in the last decade?

□ Yes □ No (If No please skip to Section E)

Section E: ERP Implementation Additional Information

E1. What ERP system was implemented?

□ Oracle□ PeopleSoft □ SAP □ JDE

□ Other, please specify ……

E2. How long has this ERP system been used in your organization?

□ Less than 2 years
□ Between 2 and 5 years
□ Between 5 and 10 years
□ More than 10 years

E3. When was the Go Live date of the last module implemented?

□ During the last 2 years
□ Between 2 and 5 years ago
□ Between 5 and 10 years ago

E4. What ERP modules were implemented?

□ Full Implementation: all processes and units
□ Partial Implementation, please specify the modules implemented:
  □ Finance
  □ Human resources
  □ Supply chain
  □ Sales & marketing
  □ Management reporting and metrics
  □ Planning and analysis
  □ Performance management
  □ Product development
  □ Customer relationship management

Section F: Respondent Information

F1. What is the number of employees in your company?

□ Less than 25
□ 25-99
□ 100-499
□ 500-999
□ 1,000-4,999
□ 5,000-9,999
□ 10,000 and over

F2. What is the annual sales volume of your company?

□ Less than $1 million
□ $1-9.99 million
□ $10-49.99 million
□ $50-99.99 million
□ $100-499.99 million
□ $500-999.99 million
□ $1 billion or more