TITLE:

Extracting Value from Enterprise Resource Planning: A Closer Look at Integration

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August 2011

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of doctor of philosophy

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Thesis Abstract

This thesis studies the process of extracting business value from Enterprise Resource Planning (ERP) through integration. The main premise is that performance differences across firms investing in similar ERP systems can be attributed to differences in the way the technology (ERP) is integrated with the actual IT infrastructure and business processes of the firm. Drawing on the entrepreneurship and integration literature, this thesis focuses on the antecedents of integration and its impact on business process performance. To better understand this phenomenon, this thesis adopts a multi-method and multi-essay approach. The first essay looks at how different degrees of integration are achieved by looking at the effect of managers' alertness and search activity on integration. It also demonstrates the influence of perceived gap as a trigger of search. The second essay develops and proposes a measure of integration in an ERP context at the module level. Finally, the last essay applies the notion of integration to better understand its effect on business process performance by looking at its antecedents and how different degrees of integration influence the performance of the business processes. All essays are empirical; case studies for the first one and survey for the last two essays. These essays can be seen as components of an integrative investigation of the issue of ERP value creation through integration, which is likely to help us understand how and under which circumstances ERP systems can produce value for the firms implementing them.

Résumé

La présente thèse étudie le processus d'extraction de valeur des systèmes de gestion intégrée (ERP). La prémisse principale de cette thèse est que la différence de performance entre les organisations qui investissent dans des systèmes ERP similaires puisse être attribuée à la façon dont le système est intégré avec l'infrastructure technologique actuelle et les processus d'affaires de l'organisation. Basé sur la littérature en entrepreneuriat et en intégration, cette thèse fait le point sur les antécédents et les impacts de l'intégration d'un module ERP. Pour mieux comprendre ce phénomène, cette thèse adopte une approche multi-méthode repartie sur trois articles. Le premier article examine comment l'intégration est accomplie à travers le niveau d'alerte et de recherche des gestionnaires, ce dernier dépendant du gap perçu entre le système et les processus d'affaires actuels. Le deuxième article développe et propose une mesure d'intégration dans un contexte ERP au niveau du module. Finalement, le dernier article applique la notion d'intégration pour mieux comprendre ses antécédents et son effet sur la performance des processus d'affaires. Tous les articles sont empiriques : études de cas pour le premier et enquête pour les deux autres articles. Ces articles peuvent être vus comme les composantes formant une vision complémentaire de l'investigation de la création de valeur des systèmes de gestion intégrée à travers le processus d'intégration.

Acknowledgements

It is a pleasure to thank those who have made this thesis possible. I must first express my gratitude towards my advisor, Dr. Alain Pinsonneault, whose encouragement, guidance, and support have been instrumental in enabling me to complete this journey. In every sense, none of this work would have been possible without him. I appreciate all of his contributions of time, ideas, and funding to make my Ph.D. experience productive and motivating. I am also thankful for the excellent example he has provided as a successful professor and advisor.

I am also especially grateful for the valuable advice and friendly help of Dr. Geneviève Bassellier. Not only did she provide me with constant suggestions as one of my committee members, but she was also always available to discuss research and teaching questions. I owe also my deepest gratitude to the two other members of my committee: Dr. Henri Barki and Dr. Robert David for their time, interest, and helpful comments. I would also like to thank the external examiner and the other members of my oral defense committee.

I warmly thank Dr. Liette Lapointe, who has assisted me in so many ways during my work at McGill. I would like to also thank all of the other members of the IS department, the Desautels Faculty of Management and the joint program, including faculty members, fellow PhD students and staff for their support. I wish to thank Shamel Addas, Dr. Olivier Caya, and Jing Wu in particular. Their insights and comments were invaluable over the years.

I gratefully acknowledge the funding sources that made my Ph.D. work possible. I was funded by a grant from FQRSC and SSHRC. I am also indebted to the Department of IS, the Desautels Faculty of Management and McGill University for direct financial aid through fellowships, awards, and travel grants.

Last but not least, I would like to thank my family and friends, who were always supportive and enthusiastic about my dissertation. Finally, thanks to my husband Chris and my son Axel, whose faithful support, love and encouragement made all of my endeavours worthwhile.

Chapter I: Introduction

Enterprise resource planning systems (ERPs) are software packages intended to enable the integration of IT applications and the complete range of business processes throughout an organization (Klaus et al. 2000; Markus and Tanis 2000). These systems enable a firm to integrate the data used through its entire organization and are replacing legacy systems to accommodate the diverse needs of organizations (Davenport 1998). They can bring important benefits, such as direct access to real-time information and the facilitation of the flow of information between the processes of an organization (Klaus et al. 2000; Markus 2000; Robey et al. 2002). Indeed, ERP systems have generated much interest among researchers and practitioners as a potential means of enhancing organizational agility (Davenport 1998; Sambamurthy et al. 2003).

Although ERP systems may have positive benefits, many firms have failed to achieve financial returns on their ERP investments or gain competitive advantage (Barki et al. 2005; Kalling 2003; Markus and Tanis 2000; Ross and Vitale 2000). Indeed, research on ERP has demonstrated mixed results regarding its impact on firm performance (Akkermans et al. 2003; Laframboise and Reyes 2005). For instance, some authors found that firms that invested in ERP tended to show higher performance across a wide variety of financial metrics (Cotteller and Bendoly, 2006; Hayes et al. 2001; Hitt et al. 2002; McAffee 2002; Ranganathan and Brown 2006), while others found a modest role of ERP in improving firm effectiveness (Akkermans et al. 2003), or no significant performance differences between ERP adopters and non-adopters (Vemuri and Palvia 2006). In other words, firms buy similar ERP packages, but some firms generate significant business value from it while others do not (Ragowsky and al. 1996; Ross et al. 1996; Shang and Seddon 2002).

Two main reasons for such differences have been proposed. First, effectiveness gains are quite difficult to measure due to the qualitative nature and intangibility of the benefits, the length of time it takes firms to realize benefits, and the different ways in which improvements become manifest (Hayes et al.

2001; Markus et al. 2000; Shang and Seddon 2002). For instance, it can take two to five years to achieve significant returns from ERP investments and benefits are often measured before that time frame (Davenport 2000; Hayes et al. 2001). Second, ERP benefits are generated only when firms realize the integrative potentialities of ERP systems (Beretta 2002; Davenport et al. 2004). More specifically, firms need to adjust their ways of working to obtain value from commercial ERP packages by integrating the system with the firm's strategy, IT infrastructure, and business processes (Barki and Pinsonneault 2005; Kien and Lian 2009: Peirera 1999; Raganathan and Brown 2006). Thus, the degree to which ERP is integrated into the existing technological infrastructure and business processes of the firm is likely to influence the final results.

The Integrating Capabilities of ERP Systems

Integration can speed up communications, improve decision-making, and link firms more easily to their customers and suppliers (Davenport et al. 2004). In contrast, unintegrated systems can create various kinds of problems for companies (Markus 2000). For instance, a lack of integration can hinder the ability to analyze data for making important decisions, put in place streamlined business processes, efficiently obtain needed reports, or respond quickly to customers' demands (Markus 2000; Markus 2001). ERP systems have integrative capabilities, i.e. they can enable business, strategic, and technical integration (Gattiker and Goodhue 2005; Ranganathan and Brown 2006; Scott and Vessey 2000). Indeed, a growing body of literature suggests that the higher the degree of ERP integration in terms of functional and physical scopes, the better a firm performs (Beretta 2002; Ranganathan and Brown 2006). For instance, it was found that ERP implementation with greater functional scope resulted in positive and higher shareholder returns and operational performance (Hitt et al. 2002; Karimi et al. 2007; Ranganathan and Brown 2006; Volkoff et al. 2005). Greater functional scope is achieved through the implementation of multiple or cross-functional ERP modules, which provides data and process integration across functions and offers more benefits than a single module implementation (Karimi

et al. 2007). Indeed, purchasers of multiple ERP modules were found to have greater financial returns than non-purchasers or purchasers of single modules (Hitt et al. 2002). Greater physical integration, which reflects the range of physical locations that the ERP implementation can reach and includes both organizational and geographic scopes, was also found to positively impact operational performance (Cotteleer and Bendoly 2006; Gattiker and Goodhue 2005; Karimi et al. 2007; Ranganathan and Brown 2006). By integrating technology and business activities across multiple locations, firms hope to reduce cost and improve business processes, data integrity, and customer service (Karimi et al. 2007). Finally, it was determined that leading firms work to integrate their ERP internally and with other firms (Davenport et al. 2004).

However, while integration has been shown to be important, firms adopting ERP have had great difficulty integrating their ERP systems with their existing business processes (Markus 2000; Markus and Tanis 2000). It is one of the major problems that ERP adopters face when implementing ERP systems (Karimi et al. 2007). For instance, it was found that between 58% and 80% of the firms faced significant integration problems when attempting to link their ERP system with existing IT applications (Themistocleous et al. 2001). Yet, little attention has been paid to providing a sound measure of ERP integration, the factors influencing it, and the effect of different degrees of integration on performance, suggesting the potential value of new research directions (Markus and Tanis 2000). This thesis attempts to fill this gap by looking at the role of managers in achieving integration. The research model suggests that the degree of ERP module integration, which influences the performance of the business processes, depends on managers' integration process and the perceived gap between the current way of working and the new ERP module. More specifically, the integration process, which is composed of the managers' level of alertness, search, and design, is one of the main antecedents to the integration. Here, integration is looked at the module level, i.e. it refers to the extent to which the components of an ERP module and its users are tightly coupled with relevant business processes, IT applications, and users. A model based on these constructs

is proposed (Figure 1) and research questions are provided below with an overview of the research model and the three essays.

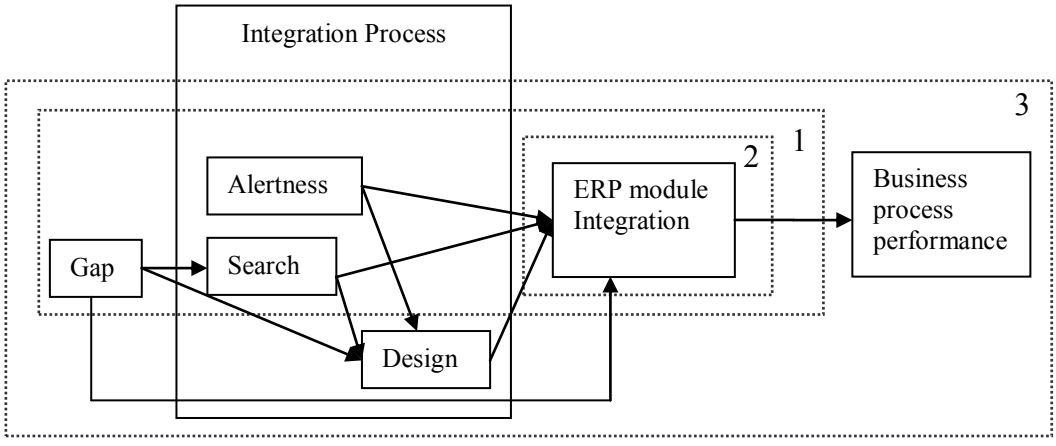
Research Questions and Research Model

Essay #1: R.Q. *How do managers' alertness, search, and perceived gap interact with ERP module integration?*

Essay #2: R.Q. *How can ERP module integration be measured?*

Essay #3: R.Q. *What is the effect of perceived gap, alertness, search, and design on ERP module integration? What is the effect of ERP module integration on business process performance?*

Figure 1. Research model



1: Essay #1; 2: Essay #2; 3: Essay #3

Model Overview

It is proposed that the integration of an ERP module, which influences the performance of the business processes, depends on the identification and exploitation of integrative opportunities, i.e. the integration process. Therefore, managers first identify opportunities by *searching* for them and being *alert* to the uniqueness of the system and/or their business processes. Second, through *design,* these opportunities are developed to achieve greater integration. Furthermore, the search and design activities as well as ERP module integration are likely to depend on managers' perceptions of the *gap* between the system and existing

business processes. For example, when managers involved in the ERP implementation perceive a small gap between the system and the actual processes, fewer changes are needed to the current technology and business processes and thus fewer integrative opportunities are likely to be searched for and exploited. In contrast, managers who perceive a larger gap are more likely to perform higher levels of search, because they believe further opportunities are likely to emerge and as such are willing to engage in a high level of design to exploit integrative opportunities. Thus, different ways to identify integrative opportunities are likely to emerge and influence the degree of *ERP module integration*. Perceived gap is also expected to influence the level of integration, i.e. lower ERP module integration should be achieved when high level of gap is perceived. Finally, greater *business process performance* should be achieved when a high level of integration is achieved. Previous research has highlighted the importance of alertness and search as being crucial to identifying technological opportunities such as ERP (Kirzner 1979). Furthermore, wide variations in the performance of firms in the same industry and using the same technology are evidence of the importance of human resources and effective management (Mata et al. 1995). Thus, managers' ability to effectively integrate an ERP module will likely influence the value extracted from ERP systems.

This thesis is therefore an effort to shed light on performance differences across firms investing in similar ERP and provides a deeper understanding of the broad issue of the business value of IT. Organizations have access to different IT resources and thus possess different IT capabilities. Such differences may explain the divergences among organizations in the use of IT and in the benefits they have gained from their deployment (Clemons and Row 1991). This study can be considered as an extension of the resource-based view and IT business value research streams, motivated by the process of effectively integrating ERP systems through managers' capabilities to find and develop opportunities with ERP. The next section introduces each essay in detail.

Essay #1: Identification of Integrative Opportunities: An Empirical Investigation of ERP

The main premise of this essay is that performance difference across firms investing in similar ERP systems can be attributed to the way the technology is integrated with the actual IT infrastructure and business processes of the firm, i.e. the integration process. Building on the entrepreneurship and resource-based view (RBV) perspectives, this essay focuses on the role of managers in the first step of the integration process, i.e. the identification of opportunities. Drawing on managers' alertness, search and perceived gap, different ways to identify integrative opportunities are analyzed. In order to address research question #1, a case research methodology has been chosen. Case research is particularly appropriate in this context since the research model is in its early formative stage, few previous studies have been carried out in this area, the roles of actors are important, and the context of action is critical. This essay is a first step toward an understanding of the process to identify integrative opportunities and is likely to help us explain how and why firms investing in similar ERP may have different levels of integration.

Essay #2: Measuring ERP Integration at the Module Level: The Development of a Construct

While the first essay indicates that ERP integration depends on the identification of opportunities, a better understanding of the conceptualization and operationalization of the ERP integration concept at the module level is proposed in the second essay. Previous literature on ERP integration has mostly measured integration by the number of modules implemented (functional) and/or the number of sites or geographic reach of implementation (physical), limiting our understanding of the effect of integration and our ability to compare results across studies. Based on a domain definition grounded in the IS literature, this second essay develops an instrument to measure ERP module integration and investigates how it influences business process performance. This instrument is tested by collecting data using a questionnaire completed by organizations that

had recently implemented an ERP module. This essay represents the initial work in developing an empirically reliable and valid measure of integration in an ERP context at the module level.

Essay #3: Antecedents of ERP Module Integration and its Impact on Business Process Performance: An Empirical Analysis

Finally, drawing on the literature on ERP and performance, the third essay develops and tests a theoretical model to investigate the degree of integration of ERP module and its impact on the performance of the business processes. Specifically, this model explains how the integration process, through search, alertness, and design, influences the degree of ERP module integration, which then influences the performance of the business processes. The model also looks at the role of perceived gap as an antecedent of search, design, and ERP module integration. The hypotheses are tested using survey data from companies that have implemented an ERP module. This essay contributes to our understanding of the role of integration in influencing business process performance and the role of managers and perceived gap as antecedents to ERP module integration.

Contributions and Dissertation Structure

ERP systems constitute a significant area of investment by global firms. They are also a source of integration for the firms that implement them. This thesis examines the process of creating value through integration by (1) suggesting that a basic structure underlines the identification of integrative opportunities and from which different degree of integration are achieved (essay #1), (2) developing a measure of ERP module integration (essay #2), and (3) proposing that higher ERP module integration leads to greater business process performance, which depends on the integration process and perceived gap (essay #3). Thus, the preceding discussion of the integration concept suggests that it can provide significant and sustainable benefits for a firm that can achieve it.

Several interesting managerial and theoretical implications are likely to emerge from the findings. As a first step toward developing an understanding of

the process to achieve integration, the decomposition of the process is expected to enable the understanding of how value is extracted from ERP systems as a result of integration and how managers convert the potential of ERP systems into realized value. Second, building a better understanding of the integration process has the potential to provide an attempt to "look inside the black box" and explanations on why achieving only physical and functional integration is not enough to extract value from ERP systems. Third, the entrepreneurship perspective is likely to offer a promising theoretical base for examining why some managers are able to extract greater benefits from IT than others by identifying and exploiting integrative opportunities. This thesis has also the potential to contribute to the literature on alertness by providing an operationalization of alertness in the IT context. Few empirical studies have provided such a measure and tested the concept in an IT setting. Fourth, by providing a complementary measure of integration to existing ERP studies, a better understanding of the effect of the degree of integration on business value is likely to emerge since previous ERP integration instruments have limited our understanding of the effect of integration on various performance measures. Finally, the explication of the integration process is expected to contribute to the resource-based perspective, which has been criticized for being static, limited, and overly focused on internal firm resources by looking at specific managerial resources (Priem and Butler 2001; Sirmon et al. 2007).

This first chapter has introduced the research topic and provided an overview of the problem, conceptual framework, methodology, and expected contributions of this study. Chapters II – IV present each essay and chapter V, the conclusion of the dissertation.

Contribution of Authors

Regarding the first essay, the paper was co-authored by Elisa Gagnon, the first author, and Alain Pinsonneault, the second author. However, the first author performed the vast majority of the work while the second author provided important advice and feedback to the first author on how to improve the paper.

Several versions of the first paper were generated and presented at different conferences and submitted to a journal. The second and third papers have not yet been submitted to journals and/or conferences.

References: (see end of thesis)

Chapter II (Essay #1): Identification of Integrative Opportunities: An Empirical Investigation of ERP[1]

Abstract: *Although we now have a fairly robust understanding of the importance of integration to obtain value from ERP, the process to achieve such integration is less understood. Drawing on entrepreneurial perspective along with insights from the resource-based view, this article focuses on the role of manager in the first step of the integration process, i.e. the identification of opportunities, which depends on managers' alertness and level of search. The level of search is also theorized to depend on managers' perception of gap. On that basis, four ways to identify integrative opportunities, namely the innovative, incremental, imitative, and status quo are uncovered and hypothesized to result in different levels of integration. Four case studies are conducted to illustrate the proposed framework. The study shows that the innovative and incremental types lead to high levels of integration, the imitative to medium level of integration, and the status quo type to low level of integration. Results shed light on the identification of integrative opportunities, a key factor influencing the level of search, and the impact of each type on the degree of integration.*

Introduction

The importance of ERP integration in explaining different impacts and achieving superior performance has been well established (Barki and Pinsonneault 2005; Ranganathan and Brown 2006). For example, greater ERP integration has been shown to provide data and process integration across multiple functions (Hitt et al. 2002; Karimi et al. 2007), to positively influence process efficiency, effectiveness, and flexibility (Karimi et al. 2007), increase the market value of the

[1] Earlier versions of this essay have been presented at the *International Conference on Information Systems* (2009), *Academy of Management* (2008), and at a workshop on Enterprise Systems (ICIS 2008).

firm (Ranganathan and Brown 2006), facilitate enterprise-level transactions across worldwide manufacturing centers (Cotteleer and Bendoly 2006), and lead to local level benefits through interplant coordination (Gattiker and Goodhue 2005). It has also been shown to allow users to have a more cross-functional overview of the company, i.e. be aware of the traverse character of cross-functional processes and have a broader perspective of their organization (El Amrani et al. 2006). Thus, the degree to which ERP is integrated into the existing technological infrastructure and business processes of the firm is likely to influence the final results (Barki and Pinsonneault 2005; Raganathan and Brown 2006).

Despite integrative capabilities, it has been found that firms adopting ERP systems have had great difficulty integrating them with their existing IT infrastructure and business processes (Beretta 2002; Davenport et al. 2004; Markus et al. 2000). For instance, it was found that 80% of the firms faced integration problems when attempting to link their ERP system with a number of existing applications, 58% of firms did not manage to integrate their ERP with existing systems, and many firms reported integration problems (Themistocleous et al. 2001). It is still one of the major problems that ERP adopters face when implementing ERP systems (Karimi et al. 2007). Yet, little attention has been paid to the antecedents to integration (Markus and Tanis 2000 Peirera 1999). The evidence from empirical studies indicates that little is known about the different activities leading to integration. In other words, what seems absent is a rich understanding of the process that links expectations regarding ERP with plans for extracting value through integration. Accordingly, it is now time to turn our attention towards how integration is achieved to better understand why organizations have difficulties integrating ERP systems.

This paper attempts to fill this gap by looking at the role of managers in identifying integration opportunities. Numerous indications point to the fact that managers' efforts to extract and convert the business value of ERP might be critical (Mata et al. 1995). Managers have important roles to play inside the organization and represent a unique organizational resource, which may help

explain why firms vary in performance when implementing the same technology (Hitt et al. 2002). By looking at the role of managers in achieving integration, a better understanding of the facilitating conditions leading to integration can be realized.

In response to the lack of theoretical understanding of this process, this paper borrows from the resource-based view and entrepreneurship literature, which focuses on the role of human resources in explaining performance difference between firms (Shane and Venkataraman 2000), to (1) identify the structure of the integration process, (2) look at the identification of opportunities as the main activity of the process, and (3) specify two important factors composing the identification: managers' alertness to opportunities and level of search, which depends on managers' perception of the gap between the new ERP and current way of working. Despite the fact that the resource-based view literature can certainly provide useful insights into which specific IT resources and capabilities are important to achieve performance, relatively less attention has been paid to the process through which value is created and how firm resources are combined to create value (Barua et al. 2004; Ray et al. 2004). More specifically, very little research has been conducted on the process through which ERP is integrated by business managers.

Significant new insights may be available about ERP integration by looking at this issue from the entrepreneurial and resource-based perspectives. In doing so, we begin to shed light on the role of managers in identifying opportunities and subsequently, the integration of ERP. More specifically, managers' alertness may help explain why some people identify opportunities while managers' perception of gap may provide the rationale for different levels of search activity to identify such opportunities. In particular, managers must act entrepreneurially, sense and seize opportunities and rethink their ways of doing things to innovate along with technology (Augier and Teece 2009). Therefore, managers who behave like entrepreneurs are likely to suggest alternative opportunities with the system that have not been previously identified and thus create new heterogeneous resources. Finally, contributions to the relatively

limited empirical work that has accounted for the process and variance in the integration of ERP systems are provided.

The rest of the paper is organized as follows. In the next section, the literature on RBV is reviewed to reveal the important role of managers in achieving integration. Then, the theoretical background is presented to provide the framework. Next, the methodology is described, followed by the analysis and results of the cases. Finally, the paper concludes with a discussion of implications for research and practice, as well as direction for future work.

Literature Review: RBV and Entrepreneurship

Two distinct, but converging, streams of literature frame the proposed research framework (Sambamurthy et al. 2003). First, the resource-based view literature contributes ideas about the importance of human resources, specifically managers, in achieving value from ERP by performing necessary integration activities. Specifically, RBV shows the importance of integrating resources to get benefits, which points to the importance of the role of managers in the process. Second, the entrepreneurship literature offers insights about the activities associated with the integration of ERP systems and frames the research framework. Relevant ideas from these two streams are highlighted in the following sections.

Resource-based view

Existing studies on the resource-based view (RBV) have yielded valuable insights into the creation of business value through the integration of firm-specific resources (Teece et al. 1997). In particular, some studies have shown that IT resources alone, such as ERP for example, cannot produce value for firms. Instead, it has been argued that IT business value resides more in how IT is combined and integrated with other resources than in the technology itself (Wade and Hulland 2004). For instance, IT assets in combination with business resources (Powell and Dent-Micallef 1997; Teo and Ranganathan 2003), senior leadership (Armstrong and Sambamurthy 1999), organizational learning (Tippins

and Sohi 2003), or supportive government policies and ample investments (Gordon et al. 2005) have been shown to lead to firm performance (see Table 1). Similarly, it was found that firms gained IT related advantages by merging IT with complementary resources, particularly with IT human resources (Ravichandran and Lertwongsatien 2005; Ray et al. 2005; Zhu and Kraemer 2005) and by combining IT infrastructure and IT-enabled intangibles resources with human resources (Bharadwaj 2000; Tanriverdi 2006; Teo and Ranganathan 2003). The effective combination of technological, organizational, and environmental resources to enable a firm to develop IT capabilities, was also found to improve operational and financial performance (Barua et al. 2004; Zhu 2004). Thus, investing in IT may not necessarily improve firm productivity or profitability but integrating IT with other resources is more likely to produce value for a firm (Bharadwaj 2000; Tippins and Sohi 2003).

Furthermore, it has been previously suggested that managerial IT skills and capabilities are likely to be a source of sustained competitive advantage (Mata et al. 1995). IT human resources were more positively correlated with firm performance than computer capital or IT infrastructure resources (Ravichandran and Lertwongsatien 2005; Ray et al. 2005) and firms with higher levels of technology competence (human resources) achieve better results (Zhu and Kraemer 2005). In other words, the key element to combine IT resources with other resources has been shown to be human capital. Resources do not combine by themselves, human interventions are needed.

Table 1. Empirical RBV studies that examine the role of human resources

Reference	Resources	Focus	Key Findings
Powell and Dent-Micallef (1997)	IT infrastructure **Human** IT-enabled intangibles	Managerial IT skills	IT alone cannot produce sustained competitive advantage (SCA); IT can leverage other intangible, **complementary** human and business resources to gain SCA.
Jarven paa and Leidner (1998)	IT infrastructure **Human** IT-enabled intangibles	Managerial IT skills	Strategic foresight and flexibility, **coupled** with a core competency of trustworthiness were found to be critical in effecting internal and external change in unstable environment.

Armstrong and Sambamurthy (1999)	IT infrastructure **Human**	Managerial IT knowledge	Senior leadership knowledge **combines** with IT infrastructure influence IT assimilation, which helps leverage the potential of IT.
Broadbent et al. (1999)	IT infrastructure **Human**	Managerial IT skills & knowledge	IT infrastructure capability is created through a unique **integration** of technology and human infrastructure.
Bharadwaj (2000)	IT infrastructure **Human** IT-enabled intangibles	Managerial IT skills Technical IT skills	A firm's IT infrastructure, its human IT skills, and its ability to leverage IT for intangible benefits serve as firm-specific resources, which in **combination** create a firm-wide IT capability.
Tippins and Sohi (2003)	**Human**	Managerial IT knowledge	To be successful, firms must **complement** IT with organizational-level learning processes.
Teo and Ranganathan (2003)	IT infrastructure **Human** IT-enabled intangibles	Managerial IT skills & knowledge Technical IT skills	IT resources in tandem with **complementary** business and human resources lead to superior firm performance.
Barua et al. (2004)	IT infrastructure IT-enabled intagibles	NA	The effective **combination** of technological, organizational, and environmental resources enables a firm to develop online information capabilities, which then leads to improved operational and financial performance.
Zhu (2004)	IT infrastructure	NA	**Combination** of IT infrastructure and E-Commerce capability positively contributes to firm performance.
Gordon et al. (2005)	IT infrastructure **Human**	Managerial IT skills	The **combination** of supportive government policies, ample investments, and well thought out operations and IT along with location and a natural deep harbor help create a sustainable competitive advantage.
Ravichandran and Lertwongsatien (2005)	IT infrastructure **Human** IT-enabled intangibles	Managerial IT skills	Variation in firm performance is explained by the extent to which **IT is used to support and enhance** a firm's core competences.
Ray et al. (2005)	IT infrastructure **Human**	Managerial IT knowledge Technical IT skills	IT resources **combine** with tacit, socially complex, firm resources explain variation in process performance across.
Zhu and Kraemer (2005)	IT infrastructure **Human**	Managerial IT skills & Knowledge	Firms create specific resources by **integrating** their systems and databases internally and with their trading partners and customers.
Tanriverdi (2006)	IT infrastructure **Human** IT-enabled intangibles	Managerial IT skills & Knowledge	**Complementarities** among IT infrastructure and IT management processes create value, which have significant effects on performance.

The role of managers (human capital) in combining resources has been studied from various perspectives, which can be grouped in two main categories, namely, managerial IT skills & knowledge and technical IT skills & knowledge. Managerial IT skills and knowledge, such as commitment of top management to IT, IS/strategy integration, integration of IT and business processes, IT management skills, shared knowledge, and the IT knowledge of senior leadership were found to be necessary to leverage the potential of IT investments (Armonstrong and Sambamurthy 1999; Bharadwaj 2000; Broadbent et al. 1999; Gordon et al. 2005; Jarvenpaa and Leidner 1998; Powell and Dent-Micallef 1997; Ray et al. 2005; Tanriverdi 2006; Tippins and Sohi 2003; Zhu and Kraemer 2005). Similarly, investing in technical IT skills was found to be essential in achieving value. Such skills did not only include current technical knowledge, but also the ability to deploy, use, and manage that knowledge (Wade and Hulland 2004). For instance, IS personnel skill, IS human resource specificity, and IT training combined with appropriate IT resources was found to lead to greater performance (Bharadwaj 2000; Teo and Ranganathan 2003; Ravichandran and Lertwongsatien 2005; Ray et al. 2005). Thus, IT human resources has been referred to IT professionals and upper management possessing the various skills and knowledge necessary to develop, implement, use, and manage different IS applications.

While the significance and importance of human capital and specifically, managers are recognized, we still know little about what exactly managers do with specific IT skills and knowledge (Bharadwaj 2000). More specifically, the role of managers to integrate the components to develop an infrastructure tailored to a firms' strategic context is complex and imperfectly understood (Kalling 2003). In other words, it has been shown that specific skills such as IT integration and IT training are necessary to have to gain value, but we do not know much about how to develop these skills. For instance, we have a limited understanding about how managers can utilize and obtain IT integration skills. This gap in the literature reveals the importance of studying how managers intervene to achieve integration. Therefore, this essay addresses this issue and extends previous

research by looking at specific activities related to integration skill. In order to do so, the entrepreneurship perspective is used since it focuses on specific actions and the role of human in achieving value such as integration (Shane and Venkataraman 2000). Furthermore, the role of the entrepreneur and the manager overlap to a considerable extent. Similar to entrepreneurs, managers need to sense and seize opportunities to achieve value (Augier and Teece 2009). Therefore, the entrepreneurial perspective can be applied as the theoretical lens to understand how managers see opportunities that others have overlooked and how they are able to activate the necessary resources to exploit those opportunities and achieve integration (Alvarez and Busenitz 2001). Overall, these two perspectives stimulate thought about the role and the specific actions by managers that will achieve integration.

Theoretical Development

The entrepreneurial process has been conceptualized as being composed of two main activities: the identification and exploitation of opportunities (Ardichvili et al. 2003; Corbett 2005; Kaish and Gilad 1991). However, as shown in previous literature, the identification of opportunities is one of the most important activities because it is the first step in the process and is likely to influence the rest of the process (Gaglio and Katz, 2001). More specifically, opportunities need to be identified before value can be achieved from a new situation (Shane and Venkatraman 2000). The exploitation activity is not likely to change across the process. It involves maintaining and improving business processes and complementary IT assets by designing appropriate solutions to achieve integration with the ERP system. Opportunities that are found during the identification activity are integrated to create capabilities that are intended to create value from ERP systems (Sirmon et al. 2007; Teece 2007). In some cases, these opportunities are objectively available to all, while in other cases, they require the insight and prior information to see that existing resources can be recombined in new ways that make them more valuable (Butler et al. 2010). Thus, the integration of ERP is composed of the identification and exploitation of

integrative opportunities, but only the first activity is the focus this essay. Finally, integrative opportunities are defined here as an occasion to introduce innovative, rather than imitative, ways to integrate current business processes and IT applications with the new ERP module (Gaglio 2004).

Identification of integrative opportunities

Before benefits can be extracted from the integration of a new ERP module, managers need to identify opportunities that have value. The identification occurs when managers make the assumption that a set of resources can be used in a more effective way (Shane and Venakataraman 2000). The ability to identify opportunities depends either on cognitive properties or because some individuals possess specific prior information (Shane and Venkataraman 2000). For example, some managers may gain value from an ERP because they have the ability to identify opportunities where the potential exists for the module to be integrated in a more efficient and/or effective manner. The cognitive limitations of managers constrain both their capacity and the flow of information they consult when identifying for opportunities (Ardichvili et al. 2003). It has been hypothesized that a number of factors influence the identification of opportunities. Research has suggested many factors influencing the identification of opportunities such as: information asymmetries, affect, industry experience, management style, search, creativity, prior knowledge, prior experience, alertness, ability to absorb uncertainty, types of opportunity, social networks, and personality traits (Alvarez and Busenitz 2001; Ardichvili et al. 2003; Baron 2008; Kirzner 1979; Shane 2000; Shane and Venkataraman 2000; Smith et al. 2009; Westhead et al. 2009).

Drawing on previous works, two factors are hypothesized to be necessary in opportunity identification: alertness and search. Indeed, the literature on entrepreneurship has mostly focused on one of these two ways to identify opportunities and more recently, has argued that they are complementary views of identification (Baron 2006; Tang and Khan 2007). The alertness perspective (Kirzner 1979) emphasizes the fact that opportunities can sometimes be recognized by individuals who are not actively searching for them, but who

possess a unique preparedness to recognize them when they exist (Gaglio and Katz 2001; Kaish and Gilad 1991). It is a perspective that helps some individuals to be more aware of changes, shifts, opportunities, and overlooked possibilities (Kirzner 1979). A heightened sense of alertness can allow an individual to quickly pick up on previously unnoticed features of the environment and quickly infer their causes and implications (Gaglio 2004). For instance, managers with high levels of alertness are expected to take advantage of ERP in a different and more effective way than less alert managers by being aware of the changes that the new ERP module will bring to their business unit. Highly alert managers will interpret the information about organizational needs, current work processes, and new technologies in a more thorough and unbiased fashion (Gaglio 2004). Information will be less likely to be disregarded when it does not fit familiar patterns, comes from different sources, or is contradictory in nature. For instance, managers may receive opposing information from competing ERP vendors, but alert managers are likely to consider this information and see how it can be used for their current work. On the other hand, less alert managers are more likely to collect and interpret information in a mechanical fashion, overlook new information, concentrate on information only from traditional sources, and focus on opportunities that fit industry trends (Gaglio and Katz 2001).

The search perspective (Fiet, 2002; Fiet et al. 2004), argues that opportunities are discovered through systematic search in areas where managers are already knowledgeable. Previous studies indicated that actively searching for information is an important factor in the identification of opportunities (Baron 2006; Fiet and Patel 2008). For example, managers may actively search for information about ERP opportunities from unique sources such as personal contacts or more specialized resources such as conferences or vendors' publications. Managers who engage in search activity are likely to transform the information to create innovative ways of integrating their ERP module (Tang and Khan 2007). The result will be innovations that change the value of an existing business process or make current integrated IT applications useless (Gatignon et al. 2004). Furthermore, it is argued here that in an ERP context, a different level

of search may depend on managers' perceptions of gap. Here, managers' perception of the gap refers to the distance between the current way of working and the one provided by the new ERP module, such as the business processes or the data used. For example, when managers perceive a large gap, they will have to change their way of working and/or change the system in order to reduce the gap. In such a situation, it is more likely that innovative opportunities will take place since managers need to innovate with the technology and/or their business processes in order to reduce the gap and a high level of search activity is needed (Tang and Khan 2007). Conversely, when a small gap is perceived, opportunities are likely to be defined as incremental, where the level of search needed is not as important as when the gap is high. The utility of search is attenuated because the explicit integration of the ERP module reduces the necessity of such activity. Thus, the gap creates the possibility of having different levels of search activity to identify opportunities.

To further clarify how the level of search and alertness may affect the identification of opportunities, each type of identification will be explained further, along with respective propositions.

The four identification types and propositions

Search and alertness, being continuous rather than dichotomous constructs, can be expected to result in various types of identification. For explanation purposes, four forms of identification, which are derived by combining the two extreme cases of alertness and search (high or low), are presented (see Figure 1). For each type, different degrees of integration are likely to be achieved**.** The degree of integration here is viewed as managers' perceptions of improvement or change in integration that can be achieved with the new ERP module. Improvements in integration are expected to be most pronounced and significant when the degree of alertness is high. Finally, the level of search is expected to be influenced by the level of perceived gap. The four identification types, namely the innovative, incremental, imitative, and status quo are described next.

Figure 1. Conceptual framework

Gap Search \ Alertness	**High**	**Low**
High	**Innovative** High integration	**Imitative** Medium integration
Low	**Incremental** High integration	**Status quo** Low integration

Innovative

In an instance in which managers engage in high level of search and are alert to new integrative opportunities, improvements in integration should be achieved. Such a scenario exhibited by managers may result in radical innovations that revolutionize the way the ERP module is integrated. Indeed, it has been suggested that when managers engage in high levels of search, because of a high gap for example, radical changes to the current way of working can be brought about (Luo and Strong 2004). Through a high level of search, managers are likely to appropriate the system and business processes in a way that is different than what they had before and make innovative, integrative discoveries. Managers are likely to perceive that implementing the system as is, i.e. the status quo, is not appropriate in this situation, and changes to the system and/or processes are needed (Gaglio and Katz 2001).

Additionally, when alertness is high, managers perceive and reason in such a way that it allows them to be more attentive to new integrative opportunities (Gaglio and Katz 2001). For example, alert managers will be less likely to miss an opportunity just because it is too different from common experience. Thus, alertness allows managers to better and more quickly recognize any anomalies that arise from changes, more accurately identify the patterns among unrelated events, and develop innovative solutions (Baron 2004; Gaglio and Katz 2001). For instance, they may improve their current business processes by using the best practices embedded in the system and discover new integrative

opportunities. Additionally, they may talk with other business units or divisions about how they implemented similar applications and/or business processes and may detect potential value by modifying their business processes, mostly because of a new way of thinking or new understanding of the business process. In turn, this should create additional opportunities to improve the integration. Managers that understand and realize the potential for integration of the ERP module are also likely to realize the need to integrate it with existing applications and business processes (Premkumar et al. 1994).

Thus, managers who engage with ERP in a substantive manner to identify opportunities for integration-enhancement are likely to achieve greater integration because the system or/and business processes are adapted to the uniqueness of the organization and integrative opportunities are searched for and sensed through managerial alertness. Therefore, in order to achieve improvements in integration, both alertness and systematic search are required.

Propositions 1: *When managers engage in a high level of search and are highly alert to integrative opportunities, a high level of integration will be achieved.*

Incremental

Situations in which managers do not feel the need to engage in a high level of search, but are highly alert, will allow them to identify unique integrative opportunities and achieve greater integration by staying on the look out for new opportunities. Because managers perceive a low gap, incremental improvements in the current way of working is performed, which reduces the degree to which managers conduct a search (Tang and Khan 2007). Fewer adaptations to the system and/or the business processes are needed and this limits the incentive of managers to actively search for ways to improve the ERP module and/or the business processes (Hong and Kim 2002).

What is important is the alertness of managers, which is likely to allow them to discover new opportunities (Kirzner 1973). Although many managers may miss these opportunities, those who are alert position themselves in

situations where integrative opportunities can more easily be identified (Gilad et al. 1989). Their heightened sense of alertness is active, allowing them to pick up on unnoticed features of the ERP module. Alert managers are most likely to consider opportunities in a critical way and take advantage of unique opportunities relevant to the context of their business unit that may have a positive impact on the integration.

Opportunities identified through alertness are likely to provide limited modifications to what already exists (Tang and Khan 2007). Refinements to current business processes are incremental instead of innovative (Baumol, 1986). For example, managers may come up with new features: perhaps a new way to automate an existing process that allows managers to have a more integrated vision of the process. Value is added to the existing business process without changing the basic nature of the process itself. Therefore, such a change does not require too much search for the necessary information and knowledge to improve the business process, but without alertness such opportunities would have been unnoticed (Tang and Khan 2007).

Although a key feature of the incremental type focuses on alertness without search, opportunity exists because some managers are attentive to the uniqueness of their business units, current way of working, or ERP knowledge (Kirzner, 1997). Alert managers can identify profitable opportunities by capitalizing on the awareness of the problems and advantages of existing business processes and IT application. Thus, improvements to integration are likely to be high because managers are aware that new integrative opportunities can still be identified, even though the new ERP module is almost the same as the current way of working.

Propositions 2: *When managers engage in low levels of search, but are highly alert to integrative opportunities, a high level of integration will be achieved.*

Imitative

Situations in which managers engage in high level of search, but are minimally alert, will tend to see imitative implementations where managers fail to substantially improve the integration of the ERP module. This large gap means that many changes and adaptations are needed to the current business processes and/or the new ERP module in order to achieve integration. Thus, search efforts are also likely to be needed in order to find ways to integrate the ERP module. However, because of the low level of alertness, managers may not detect that they have unique business processes and that the ones provided by the new ERP module are not appropriate to their needs. They may also not perceive the signals to change their current business processes and, therefore, limit their search activity to known areas (Gaglio 2004). Managers do not stay alert to new integrative opportunities and are attracted by the option of imitating previous implementations or implementing the "best practice" embedded in the ERP module. Because of their low level of alertness, managers are also likely to succumb to mimetic pressures from the environment to economize on the search costs, dealing with the system by imitating the choices of other organizations (Liang et al. 2007).

Managers who are less alert are not as motivated as those who are alert to stay attentive to integrative opportunities (Tang et al. 2007). Indeed, minimally alert managers are likely to fail to identify integrative opportunities because they misjudge their environment and what is unique about their organization or business unit. They either discount or do not detect informational cues indicating that the current way of doing business may no longer be as efficient or as effective as before. Consequently, less alert managers believe that their behavioral requirements consist of allocating their existing resources in ways that historically have had the highest probability of maximized returns or have been congruent with previous institutional responses (Gaglio and Katz 2001). They believe that there are no more concrete opportunities to be discovered, therefore, they will be most likely to overlook opportunities that are too different from what

they are accustomed to and will tend to assess information consistently with the dominant perspectives widely accepted in the industry or in the organization.

Thus, managers are likely to focus on identifying opportunities the same way as before, limiting their search activity to knowledgeable sources and missing out on discovering new opportunities. Managers will be searching for ways to improve a business process upon what already exists or stopping the search activity after the first plausible solution, yet not venture too far from a particular domain of knowledge to which the manager is alert (Tang and Khan 2007). For example, managers may imitate an existing business process in their business unit and implement this process with minor variations. Thus, if managers limit their search activity to known domain and are not alert to new integrative opportunities, medium improvements in integration will be achieved.

Propositions 3: *When managers engage in a high level of search, but are not very alert to integrative opportunities, a medium level of integration will be achieved.*

Status Quo

When managers do not engage in a high level of search and are weakly alert, limited gain in integration will be achieved. Because of the low gap, managers do not need to put in extensive effort to search for integrative opportunities. Furthermore, because of their low level of alertness, they are likely to feel that their existing business processes and the one provided by the new system adequately support their business objectives. Managers are not likely to stay alert to new possibilities that the new system may offer in regards to integration or the uniqueness of their way of working. For instance, they are not likely to stay alert to possible cross-functional benefits that a new ERP module may offer to their business unit. They are unable to take the ERP system further than installation and are happy when their operations are as reliable as they were with the old systems. This type is characterized by what has been defined as a mindset that the ERP is a silver bullet and a quick fix, not an opportunity to achieve greater integration (Markus and Benjamin 1997).

Vanilla implementation is more likely to be chosen, i.e. no modifications to either the system and/or business processes. Managers are likely to discount each anomaly when encountered and this interpretive behavior allows them to conclude that nothing has or would need to change; that is, they could maintain the status quo (Gaglio and Katz 2001). Less alert managers are not even aware there is data on potential new opportunities for integration and may fail to recognize that the current way of working is no longer appropriate (Kirzner 1979). They have the mindset that the best practices provided by the ERP will support their current needs (Galio 2004). However, these best practices are designed to offer the most common features, which may not be the ones needed by the company. Further, if modifications are made to the system, less alert managers are most likely to accept changes that do not fully satisfy their needs assuming that the system will still be supporting their major work and help them with better integration

The business unit and organization may still benefit from automation or the best practices imbedded in the new system, but old business processes problems are likely to persist and new integrative opportunities stay unnoticed. The result is the implementation of the ERP with limited improvements in integration.

Proposition 4*: When managers engage in a low level of search and are not very alert to integrative opportunities, low level of integration will be achieved.*

Method

Research sites

To illustrate the four situations, case studies were conducted in two North American companies. One organization was in the pharmaceutical industry and the other one in the steel industry. The four cases were selected according to the go-live date of the ERP project, i.e. less than 2 years since a retrospective approach was applied. This approach allowed to measure integration while not being too distant from the subject time.

PharmaCo

PharmaCo is a US-based $22.4 billion producer of pharmaceutical, consumer, and animal health care products with nearly 48,000 employees at more than 145 sales and 100 manufacturing sites worldwide. In Canada, there are 4 divisions and two of them were used for this study: PharmaCo ML and PharmaCo MS. In the late 1990's the U.S. headquarters embarked on a multi-phased, multi-location ERP implementation of a full range of SAP modules. PharmaCo decided to implement a single instance of SAP across all of its worldwide divisions, with the Canadian divisions a part of the first wave. The project started in September 2006 with a Big Bang approach toward SAP and went live in February 2008.

PharmaCo ML's division has about 1,300 employees and 700 of them use the ERP system. They implemented 13 modules and add-ons. About 20 people were involved in the project, which was one of the biggest IT projects in Canada in 2007. Four actors who were involved in the project were interviewed: the director of IS and three managers from the engineering, logistic, and finance departments. Thus, two modules in distinct business units were studied. First, the engineering department, which employs about 75 people, implemented the maintenance module with a team of two people and the SAP expert. Second, the finance department is comprised of 22 employees and four of them were involved full time in the project to implement the finance module.

PharmaCo MS's division has about 200 employees and 100 of them are sales employees who do not use the ERP system. Similar to PharmaCo ML, the project started in September 2006 and went live in February 2009. However, the scope of the implementation was less and 3 modules and 3 add-ons were implemented using a big-bang approach. They used an implementation partner and about 11 people from different departments. The president of the company and two site leads were interviewed and the finance module was studied. Three people were involved in the project; from those involved, the director of financial systems and treasury was interviewed.

SteelCo

SteelCo is an integrated steel company headquartered in Ontario, which employs over 7,000 people. In September 2006, the company started an ERP implementation project of 5 SAP modules. The project went live in May 2007 and now 13 employees are using the system. They went into SAP to experiment with the ERP system by putting in place a paired down version to see if it would be beneficial to roll it out corporate-wide in the future. The team consisted of 40 people (7 business managers) and two of the team members, one from the procurement and one from the sales department, were interviewed. The procurement division has 60 employees but only 3 of them use the system. The material management module was studied.

Data collection

Data collection started in August 2008 and concluded in December 2008. Data sources included interviews and project documentation. Using multiple sources of data allowed the triangulation of the data and provided an appropriate level of internal validity (Miles and Huberman 1994). Multiple research sites were selected to enhance case depth, comparability, and data quality. To improve reliability, a traceable, documented justification of the process by which conclusions were reached was done (Yin 2003). Specifically, a case study protocol was developed, which contains the instrument used to collect the data, as well as the procedures to be followed when collecting data.

Table 2. Data collection

Organization	Respondents (#)	Module	Search	Alertness
PharmaCo ML	IT professionals (1) Functional managers (3)	Finance	High	High
		Maintenance	Low	Low
PharmaCo MS	Top executives (1) IT professionals (1) Functional managers (1)	Finance	Low	High
SteelCo	Functional managers (2)	MM	High	Low

Four semi-structured interviews were conducted in PharmaCo ML, three in PharmaCo MS, and two in SteelCo (see Table 2). The interviews lasted from 30 minutes to 1.5 hours. Follow-up e-mails and interviews were sent to request clarifications and to offer informants an opportunity to provide feedback. Interviews were all tape-recorded and fully transcribed. In each organization, the same procedure was followed. First, information on the ERP project through interviews with IT professionals or top executives was gathered. Information specific to the module was obtained by interviewing managers involved in the implementation. The second step consisted of studying the identification of opportunities (search and alertness) and the level of gap of the four ERP modules.

Table 3. Operationalization of constructs

Construct	Operationalization	Theoretical support
Alertness	Managers involved in the implementation of the ERP module were trying to take advantage of the system to facilitate their work, attentive to unique needs of their unit, alert to the possibilities with the system, and bringing new ideas to improve the system.	Gaglio and Katz 2001
Search	Managers involved in the implementation of the ERP module read publications, talked to other divisions/managers, searched for ways to improve current processes, etc.	Mu 2007
Integration	Now with the new ERP module, how the (1) information is shared between the departments, (2) different types of information are shared, and (3) business processes are tied with the other department. Also, perceived % of improvements in integration achieved with the new module.	Karimi et al. 2007; Liang et al. 2007
Perceived gap	Perceived percentage of gap # of processes that needed modification. # of changes made to the system.	Wang et al. 2005;Soh and Sia 2005

As shown in Table 3, managers were thus asked to described the extent to which they searched for opportunities to achieve integration, read publications on ERP -related implementations, talked to other divisions (search); the extent to which managers involved in the implementation of the ERP module were attentive to unique needs, tried to take advantage of the system to facilitate their work, were alert to the possibilities with the system, and brought about new ideas to improve the system (alertness); how the information is shared and exchanged

now and business processes are tied (integration), the percentage of business processes that fitted with the new system, the percentage and number of changes that were made to the system and the percentage and number of business processes that needed modifications (perceived gap). Perceived gap was defined as "high" when it was over 20%, as a previous study of SAP users reported that on average at least 20% of their need functionality was missing from the package (Scott and Kaindl 2000).

Data analysis

All collected documents and interviews were entered into a database for analysis. Data reduction, data display, and conclusion drawing and verification were concurrently carried out in data analysis (Yin 2003). The initial analyses occurred parallel to data collection, i.e. while conducting the interviews, transcripts and comments were read and analysis was written (Eisenhardt 1989). A multistep analysis process was used. First, interview transcripts were read several times by one author in order to become immersed in the data. An extensive case description, which included the geography and setting of the site, project specifications and key actors and their relationships, was documented. In the next phase, within-case analysis was performed to allow the unique pattern of each case to emerge and provide researchers with a rich understanding of case, and hence, accelerate cross-cases analysis. Thus, the information regarding each identification type was put into a Word document and coded using a coding scheme. Third, chains of evidence describing the identification, integration, alertness, and perceived gap were constructed. Fourth, cross-case analysis was conducted, grouping the identification types that were similar according to the degree to alertness and perceived gap. Fifth, an iterative approach to validate relationships between alertness, perceived gap, search, and integration was taken (Eisenhardt 1989). Finally, since a single coder was used, the findings were sent back by email to the respondents to validate the information and the chains of evidence.

Results

The chains of evidence relating to the four types are presented and discussed below: innovative (Finance module, PharmaCo ML), incremental (Finance module, PharmaCo MS), imitative (MM module, SteelCo), and status quo (Maintenance module, PharmaCo ML).

Innovative: finance module at PharmaCo ML

The finance module, which was implemented in the finance department at PharmaCo ML, did not fit the needs of the department to a large extent. About 50 percent of the business process needed modifications and the system and/or the business processes were modified, i.e. about half of those had changes (see Table 4, quote #2). Thus, managers perceived a high gap. However, they were convinced that the new module had great potential to improve their job by being more integrated. The managers were alert and always looking to challenge what was proposed to the department (Q1). For instance, when asked if the team was alert to new opportunities, the managers said: "always…we were looking to be more efficient, to improve accuracy and be more integrated". Furthermore, the interviewee felt that the managers involved in the implementation were above other divisions in terms of alertness, which implemented the same module but had different outcomes. For instance, the manager stated that: *The other division was kind of faced with taking it 'as is'.* Because of the high gap, managers had to spend time and effort searching for ways to do *things accurately, but quickly*, and in the same time, search for ways to enhance the integration of the module. Managers searched by talking with other divisions similar to them and brainstorming with other people knowledgeable about the finance processes (Q3). For example, the month-end closing process of PharmaCo ML is completely different than other sites, and managers had to: (1) search for information on how other sites do it, (2) find ways to make it work with people knowledgeable about SAP and others who may not have necessarily been on the team, but individuals in finance who were knowledgeable about finance processes. Thus, their high

alertness allowed them to always be looking to challenge what was proposed and fight for the changes that they thought would help the integration.

Finally, managers involved in the implementation of the finance module at PharmaCo ML performed a high level of search, were highly alert, and were able to discover new integrative opportunities with the module to make it as efficient as possible and gain higher integration. As Q4 indicates, significant improvements in integration were obtained, i.e. the system now empowers the department to be better coupled with other departments inside and outside the division and allows them to communicate a lot more with the other departments and divisions, have processes that are more automated, and information be more accurate. For example, the manager said that *people can spot things when things are wrong… because we're so integrated, they're running reports, and saying "Hey, you guys, you still have to balance somewhere".* This case illustrates and provides preliminary support to the first proposition.

Table 4. Innovative

Alertness	Gap	Search	Integration
Q1. "W*e were always looking to be more efficient, to improve accuracy, and to challenge…when you feel as a business team that you have a good proposal on the table, you challenge it as much as possible, and, you know, you fight for priority changes, rather than accept the system as is…".*	**Q2.** *"There may have been some minor adjustments, but, overall, those processes remain the same, but there were, a large amount, 50 percent, where…did not fit PharmaCo ML's needs".*	**Q3.** *"What we had to do was kind of brainstorm, and with their knowledge of SAP and our requirements worked together, and seek other people who may not have necessarily been on the team, but these were finance people and we searched for solution".*	**Q4**. *"We probably talk a lot more now than we ever did before… people can spot things when things are wrong because we're so integrated, they're running reports, and saying: "Hey, you guys, you still have to balance somewhere." "Oh, where'd you see that?" Oh, well, you know, they can see it now. You catch things quicker".*

Incremental: Finance module at PharmaCo MS

The finance department at PharmaCo MS implemented the finance module, but differently than the PharmaCo ML division since they had dissimilar processes. Managers in charge of the implementation in this department were highly alert to

opportunities with the system; they had a different mindset then the rest of the division (Table 5, Q.1). Indeed, the interviewee argued that the rest of the MS division was not looking at the best business practices embedded in the system because: *they have not changed what they do on the front end, they just have a bigger engine on the back end.* Managers' perceptions of gap were low; i.e approximately 20% of their processes did not fit to the corporate global model (Q.2). For the identification step, the search activity was relatively low since managers knew what they wanted from the system, i.e. they did not have to talk to other divisions or look at what other divisions were doing. Most of the processes and the system did not need major changes. Instead, managers were attentive to the unique needs of their unit and what opportunities the ERP module could offer to them. For instance, some processes were just an inefficient way of managing and they got rid of them and let SAP manage them. Other processes were done manually and managers were prepared to think about counterintuitive ways to automate them since it would lead greater integration. For example:

> *On the finance side it was a little different because we saw that we do everything manually so everything was manual, lockboxes, you know, receipts from customers…they were process improvements so we were initially looking after.*

Finally, high level of integration was achieved through greater tightness with the other departments (Q. 8). Therefore, because of the low gap, it did not require too much planned search for the necessary information and knowledge to improve the module. Instead, their high level of alertness allows them to be prepared to discover new opportunities and achieve greater integration. Indeed, the global perspective was that if the current model was an 85% fit for the rest, managers would have *to tweak or adjust, fine-tune, whatever, to manage their business on it*. Thus, differences among the ways managers decided to take advantage of the system would influence the integration. In this case, manager's high alertness allowed them to constantly stay on the look-out and extract the most out of the system, not just implement the system as-is. This case illustrates and provides preliminary supports to the second proposition, i.e. when the gap is

low, search is also low, but because of the high alertness, a high level of integration can still be achieved.

Table 5. Incremental

Alertness	Gap	Search	Integration
Q1. *"Yeah, we had a very different mindset in finance compared to the rest of the company. We knew what opportunities the ERP module could offer us."*	**Q2**."*Approximately 20% of our business processes did not fit to the corporate global model".*	**Q3.** *"No, we did not have to search or talk to other people".*	**Q4.** "*That's right. There's more integration, more tightness within the teams or within the departments…We are now more integrated than ever before, probably 90%.".*

Imitative: MM module at SteelCo

The procurement department at SteelCo implemented the material management (MM) module and the managers involved in the implementation were weakly alert, i.e. they were not looking for new opportunities with the module or what opportunities the ERP module could offer them. (Table 6, Q.1). Instead, they tried to achieve what they had set to do and worked in that direction: *We believe we've done everything we set out to do…* Managers' perceptions of the gap were fairly high, claiming that about 35-50% of the processes that did not fit the system and all processes were changed to a certain extent (Q2). Managers did search for ways to make the processes better and more integrated (Q3). For instance, they talked to consultants and other companies about similar processes or solutions to reduce the gap. However, they did not try to think outside the box and be alert to new opportunities. Instead, they said that they *wanted to follow SAP as much as possible*, imitate what was proposed even if it would mean less information or no changes. Thus, they overlooked new opportunities and instead concentrated on what they knew would work. For instance, for the storage process it was explained that:

> *First we wanted everything at a high level of details, but then we understood that what you would need to do and how much effort that's going to be. That's when the thought process says "No, we'd have to hire an army of people to do this." So then we said "no, we're going to have to make some enhancements to the system to have it do a lot of that verification versus a person doing all that."*

Finally, some improvements in integration have been achieved, but compared to the two previous cases the improvements in integration are not as high (Q4). Therefore, because of the high gap, high search activity was necessary, but managers' low level of alertness did not allow them to extract the most out of the system by looking for new opportunities, which led to a medium level of integration. This case case illustrates and provides preliminary support to the third proposition.

Table 6. Imitative

Alertness	Gap	Search	Integration
Q1. *"Our vision was to be able to meet DOC requirements, manage the inventory, provide detailed information to the item level, manage the validity of the information, and reduce manual processes…we were not alert to new opportunities"*	**Q2.** *"So say 35% to 50% of our processes did not fit the system… we changed 100% of our processes".*	**Q3.** "*Well we talked to the consultant. Other companies… no. Well we did talk to other companies before, but not about the service entry sheet. Since then we have talked to some of our sister companies and they also have enhancements for this."*	**Q4.** *"It's about 75% better in information exchange and the ability to track the actual details of the information is exactly the same".*

Status Quo: Maintenance Module at PharmaCo ML

The engineering department at PharmaCo ML implemented the maintenance module and managers perceived a low gap, i.e. 95% of the module fitted the actual model and only one or two modifications were needed (Table 7, Q2). Managers were preoccupied with implementing the system as is and concentrating on change management instead of being alert to new opportunities (Q.1). They knew that there were possible opportunities with the system but mostly wanted to follow the global model and the status quo. As explained: *we were going to implement the module like we are working right now*. Moreover, they argued that:

> *We know that there are still some opportunities with the system but we mostly concentrated on the global model and how we can use the system as is…Of course we could look to modify the system, to have the information we are missing, but we don't tend to do that, we are waiting on the global model.*

Regarding the search activity, managers did not talk to other divisions or look at what other divisions were doing with the same module (Q3). Finally, the gain in integration was limited (Q4). As stated by one of the managers, *the order process has to communicate with the planning and production departments, but it is not integrated now.* In addition, for one of the process, there is less information provided on the report than before and there is a functionality that is no longer there (Q5). This illustrates and is consistent with the fourth proposition. Managers' low perceived gap led them to perform a minimal search, and their low level of alertness did not allow them to discover new opportunities, which resulted in limited gain from integration, i.e. a low level of integration.

Table 7. Status Quo

Alertness	Gap	Search	Integration
Q.1 *"so for us, it was the base, we implemented the system as-is and we concentrated on change management…but we didn't have to challenge the system…the approach was more how can we use the system as is".*	**Q2. "***For this module, there was one or two modifications … not much… 95% fitted with the actual processes".*	**Q3.** *"No... we did not have to see how other divisions did…no visit".*	**Q4** *"..hum…not more, not more integration…* **Q5.** *" it is the same but there is a functionality that was there before on the work order, which was their name, and when you printed the work order, you could find in the pile, you know, you were able to see it. Now, we don't see it".*

Discussion

Research in the ERP literature has increasingly recognized the role of integration. However, the process to achieve such integration has received little attention and is misunderstood. A better understanding of what managers do when achieving integration and its impact on the improvements in integration was provided with this study. More specifically, the first step of the integration process, the identification of integrative opportunities, was investigated. Integrative opportunities were identified by managers depending on their degree of alertness and search, which influenced improvements in integration. Furthermore, the concept of perceived gap was added to the model to better understand the role of search in an ERP context, i.e. perceived gap was proposed to influence the level of search needed by managers.

The results have shown that alert managers who perceived a high gap engaged in high-level search and achieved a high level of integration (innovative). Similarly, alert managers who perceived a low gap and engaged in low level of search also achieved a high level of search (incremental). Thus, the innovative and incremental types appeared to maximize the integration of an ERP module by having managers be alert to integrative opportunities and investing effort in searching for them in the case of a high gap. Conversely, less alert managers achieved low to medium levels of integration depending on whether they overlooked opportunities (status quo) or engaged in search activity but imitated previous implementation without taking into consideration the uniqueness of the organization and overlooking integrative opportunities (imitative).

The results of this study relate to the ERP literature by specifying why and how not all ERP implementations achieve a high level of integration. Managers have an important role to play, not only in the case of a high gap, but also when there is a low gap. They have to search for opportunities and stay alert to possible new opportunities to integrate the ERP module. This study is also connected to the literature on system development and implementation in general by providing a framework that should encourage top management to create a friendly environment that fosters managers to be actively involved in the development and the implementation of technologies; specifically, an environment that will help to promote the alertness of managers and their desire to search for technological opportunities. Thus, managers also have an important role to play in the development and implementation of technologies. Finally, this study related to the resource-based view literature by providing support to the importance of human resources and demonstrating the specific activities of the integration skill.

Contributions

This paper extends previous efforts to better clarify the domain of ERP integration in two important ways. First, it was shown how theory from another

area of inquiry can be a very helpful exploration tool for inquiring into and creating a better understanding of ERP-integration related phenomena. The opportunity identification literature and entrepreneurship perspective were used to demonstrate how ERP integration generally involves the managers' unique alertness to opportunities and the ability to search for opportunities. Second, by looking at ERP integration through an entrepreneurial lens, the boundaries of the literature on ERP integration and entrepreneurship have been extended and enriched. In doing so, new light on how and why managers find new integrative opportunities have been shed.

As a result of taking an entrepreneurial perspective, one contribution is that we are now able to provide a first step toward developing an understanding of the process to achieve integration. More specifically, the framework helps explain and predict how and why managers will be able to extract value from ERP systems through integration, given that much work has shown that higher integration leads to greater benefits. Grounding the predictions in the managers' alertness and search allows for variations to occur among and within organizations implementing similar ERP modules. This study suggests that when managers are alert and they need to make an effort to search for opportunities (in the case of high gap), the gain in integration is also high.

Furthermore, this study extends previous ERP integration studies by looking at integration at the module level. The findings demonstrate that for the same organization, different improvements in integration were found. Previous studies have taken a single measure of ERP integration, rather than measuring it on a business-unit-by-business-unit basis or module level, capturing only a single, aggregated assessment and failed to tease out that business units may achieve integration differently than others (Gattiker and Goodhue 2005). For instance, implementing multiple modules does not necessarily lead to greater integration, unless managers are alert to integrative opportunities. Indeed, this was the case of PharmaCo MS, where finance managers were highly alert compared to the rest of the company, and were able to achieve greater integration with the finance module compared to other modules in the division and outside the division.

Finally, this study provides support to the RBV literature by providing specific action to one specific managerial resource: managers' integration skills. In response to this missing link between resource possession and resource exploitation, a better understanding of what exactly managers do with specific IT skills and knowledge was provided. Previous research has suggested that specific actions that firms or individuals take to exploit resources are not self-evident and should be further defined (Barney 1991). In this study, managers can achieve better integration by identifying integrative opportunities, i.e. by being on the lookout and searching for new integrative opportunities. Thus, the process through which particular resources (human) provide advantage is better understood.

This study also makes contributions to practices. The conventional wisdom, that an organization should change their business processes to fit the ERP system which embeds best practices and implements a "vanilla" strategy that delivers a minimally modified system, may not be appropriate in all situations. Indeed, organizations often find that they are left with a system that fails to deliver anticipated benefits when only leveraging the best practices inscribed in the system. This framework proposes that, most importantly, managers should realize that it is no longer sufficient for them to be passive functional experts as in the traditional system development projects: they have a much bigger role in ERP implementation projects (Soh et al. 2000). More specifically, they need to understand the uniqueness of their processes and be aware of potential integrative opportunities with the ERP. Thus, managers involved in ERP projects can contribute to the outcome of the project. More specifically, alertness plays an important role in identifying opportunities, or unique ways, to integrate the technology with existing IT infrastructure. Instead of implementing the system as-is, alert managers are looking at opportunities with the system. They apprehend informational cues about the technology, identify the true driving forces and critical factors of the technology, and correctly infer the potential value of the technology. They try to figure out what is going on with the technology and how it is going to affect their unit, the

organization, and the industry. They can also challenge the proposed solutions and not accept the first one. Finally, in the case of a large gap, managers have an even more important role. They have to not only be alert, but also search for opportunities. For instance, managers can inquire about how other companies do with similar processes and talk with consultants and vendors. Finally, managers can mobilize knowledgeable people to obtain their input about a specific process or a specific part of the ERP system.

Study limitations and future research

The present paper has some limitations, which could be addressed in future research. First, our understanding of the four ERP modules is largely based on qualitative insights provided by a small set of respondents. While confirmation by multiple respondents helps to increase the confidence in the validity of the findings, personal biases in the construction of the narratives cannot be ruled out. More specifically, the retrospective nature of this empirical study might have left room for a recall bias from the respondents. Despite careful attention to this issue, it is possible that some respondents reported weaker or distorted stories about the degree of alertness, search, perceived gap, and integration. Future studies could be done to gather data in real-time and longitudinally to avoid such bias.

Second, due to the intensive nature of the data collection and analysis, the study is limited to three organizations and four cases, which limits the generalizability of our results across dissimilar settings. Thus, the generalization of the findings to other contexts must be done very cautiously. Indeed, other processes are likely to emerge, which could be assessed with a study using a survey or more case studies. In other words, other factors may play a significant role in the identification of opportunities. For instance, ERP systems are really about closely integrating different business functions; thus, the role of interdepartmental co-operation and communication as one of the factors influencing the identification could be assessed (Akkermans and van Helden 2002). In the same direction, it would be interesting to look at the impact of each type on business value or different types of outcomes. Identifying the impact of

each type on a different outcome - such as efficiency, effectiveness, and flexibility - would provide useful advice to organizations regarding ERP implementation.

There are also research avenues of interest that emerge from this present work. First, it has been showed that different degrees of alertness exist, but only two types have been found in this study. However, the manager from the finance department at PharmaCo ML argued that another division implemented the same module with less integration, which seems to be influenced by the team's alertness. More specifically, a lower level of alertness and lower capability to challenge what was proposed (implementation as-is) contributed to different results. Adding another factor, i.e. the degree or ability to challenge and using a survey could help us provide a repertoire of identification types, which could then lead to the creation of a taxonomy based on the nature of the integration.

Second, the concept of alertness could be further studied by looking at its antecedents and defining other types of alertness. For instance, prior knowledge, competence, experience, and training of team members could be important factors of success influencing the degree of alertness in an ERP context. It seems there has not been much research regarding the impact of competence on ERP implementation success (Akkermans and Helden 2002). Indeed, this unique feature of being alert to opportunities differentiates managers. However, it cannot be assumed that alertness will occur automatically or that individuals are aware of or able to turn it on whenever they want. There has to be an external incentive that "switches on" alertness. For instance, top management may promote alertness among the managers and it would be interesting to look at how and when it is done. Also, there is more research to be done to provide a better measure of the different degrees of alertness.

Finally, the link between different degrees of integration and performance has received limited empirical efforts. It would be interesting to look at how the different types, which lead to different levels of integration, influence the performance of the business processes, for example. Therefore, the impact of the level of integration on different outcomes should receive further investigation.

Conclusion

This study investigates how the integration of an ERP module is achieved by looking at the identification of integrative opportunities of four ERP modules in two organizations. By analysing these identification types, the factors that can play a role in integrating new ERP modules with existing IT infrastructure and business processes have been explored. Based on the degree of alertness of managers and their level of search, four types were identified, namely: innovative, incremental, imitative, and status quo. It was demonstrated how these types influenced the integration, thus providing an enriched understanding of the complex phenomena of integration. Despite the fact that it may be possible for all firms to acquire the same ERP, results indicate that not all firms are equally successful in extracting the full potential of these systems. While the paper answers some questions about the integration of new technologies, it also raises numerous issues. As such, it is hoped that the paper will stimulate and serve as the foundation for future research on the topic.

References: (see the end of the thesis)

Chapter III (Essay#2): Measuring ERP Integration at the Module Level: The Development of a Construct

Abstract: *The concept of ERP integration has received a significant amount of attention in the research because of its potential for affecting organizational outcomes, including competitive advantage, firm performance, and business process performance. Although the importance of ERP integration has been established, the development of a valid, reliable instrument to measure this construct has not been reported in the literature. As such, further development of the implications related to the integration of ERP is warranted, especially measurement of the construct. Based on a domain definition grounded in the literature, this essay represents the initial work in developing an empirically reliable and valid measure of integration in an ERP context at the module level. The results show a 3-dimension construct for assessing ERP module integration, derived from a sample of 68 ERP module implementations. The evidence suggests that ERP module integration is formed by system, business process, and user dimensions. Evidence of reliability and discriminant, construct, and content validity are presented for the hypothesized measurement models.*

Introduction

The idea of using enterprise resource planning systems (ERP) to integrate the various business processes, IS applications, and functions of the enterprise is widespread among researchers and managers. Indeed, integrating ERP systems with existing IT infrastructure and business processes is considered a necessity to reduce complexity in a competitive environment and a major determinant of efficiency, effectiveness, and competitiveness in organizations (Beretta 2004; Karmi et al. 2007; Wainwright and Waring 2004). Effects of integration on performance have also been demonstrated in organization at both the process and firm level where leading firms worked to integrate their ERP internally and with other firms to extract value from such systems (Cotteleer and Bendoly 2006;

Davenport et al. 2004; Gattiker and Goodhue 2005; Hitt et al. 2002; Karimi et al. 2007; Ranganathan and Brown 2006).

Despite the key role of integration in the ERP phenomenon, there is little *empirical* research that provides a comprehensive measure of ERP integration to fully understand its role (Kien and Lian 2009).The current dominant way focuses on measuring ERP integration at the organizational level by looking at the scope of the implementation. More specifically, previous research has measured ERP integration by the number of modules implemented (functional scope) and/or the number of sites that the ERP system can reach (physical scope). Such studies infer that firms with greater functional and/or physical scope have greater potential for benefits resulting from the integration potential of the ERP systems (Ranganathan and Brown 2006). For instance, past research has shown that ERP projects with greater scope result in positive, higher shareholder returns whereas ERP projects with lesser scope result in negative returns (Karimi et al. 2007). Extent of ERP implementation, or scope, is important not only because it specifies what benefits can be obtained, but also because it defines the changes to managerial autonomy, task coordination, and the degree to which it will change process integration in the business units of the enterprise (Barki et al. 2005; Karimi et al. 2007; Markus 2000). Implementation of only the financial module of an ERP package in one business unit has the potential for quite different benefits, as less integration is achieved, than implementation of all ERP modules in every unit. In this respect, the notion of ERP integration has been defined as functional and physical scope.

However, such measure represents more the willingness of an organization to link its different functional units within or across different geographic regions than the actual integration (Barki et al. 2005). Although one may be able to discern that an ERP has potential for integration through its scope, it does not provide the extent to which that is the case, whether greater integration was achieved with greater scope, or why ERP is selectively beneficial for firms implementing an ERP system with the same scope. Furthermore, relatively little is known about how business units leverage their ERP modules to improve their

business outcomes. Previous studies have taken an aggregate approach toward ERP integration, capturing only a single assessment of integration at the organizational level. Rather than measuring it on a business-unit-by-business-unit basis, previous studies have failed to uncover if each business unit achieves integration the same as others, which could help explain differences among firms implementing the same ERP, i.e. with the same scope (Gattiker and Goodhue 2005).

Building on previous work on the effects of ERP integration on operational outcomes (Gattiker and Goodhue 2005; Karimi et al. 2007), ERP integration is defined here at the module level, i.e. the degree of integration is measured for each module implemented in the organization, which can vary across the same organization. Rather than conceptualizing ERP integration at the firm level as the IS and integration literature has traditionally done, a conceptualization and evaluation of ERP integration at the process level is proposed (Tallon 2007). Such conceptualization is likely to help us understand differences in benefits at the module level and yield key insights into the link between ERP module integration and business process performance (Gattiker and Goohdue 2005). Furthermore, there is a need to test a model that captures different degrees of integration at the module level (Gattiker and Goodhue 2005). To do so, we build on previous studies on integration and look at the components of integration. A more detailed approach of integration should help us understand its nature and the influence of its components on business process performance.

Since there is a clear need for valid instruments that capture ERP module integration for both research and organizational assessment purposes, it is appropriate to revisit the construct and consider a new instrument that has solid theoretical underpinnings and that meet current measurement validity standards. In an attempt to capture the essence of ERP module integration, the specific research goals are to develop an instrument that: (1) conceptualizes and measures ERP module integration and (2) demonstrates reliability and construct validity. The research described herein represents a rigorous attempt at creating an instrument to assess ERP module integration through the empirical development

of a valid and reliable measure. In doing so, it provides a systematic technique for collecting, analyzing, and interpreting data about ERP module integration for application in organizational research. This undertaking is significant to have a better understanding of ERP module integration and empirical research on ERP will benefit from a quantitative means of measuring the concept.

The remainder of the paper is organized as follows. First, the literature on ERP and IS integration is reviewed to propose a complementary conceptualization of the construct of ERP module integration. Then, the development of measures including validation process is presented. Following that, the sampling design and analysis are described in detail. Finally, contributions and limitations of the study are discussed, along with avenues for future research.

Literature Review: Past Conceptualization of Integration

There are many research streams that attempt to address the concept of integration, resulting in different definitions and conceptualizations of integration. As shown in appendix A, there have also been various approaches developed in the IS literature within the supply chain, operations and productions management, electronic data interchange (EDI), e-business, inter-organizational systems, and ERP research. A comprehensive review and synthesis of this literature suggests that while researchers' views of IS integration differ in definition and scope, there are some similarities in the myriad of conceptualizations proposed. The cumulative IS integration research can be parsed into: (1) studies that refer to integration as the scope of the implementation, (2) studies that identify integration as a technical feature, and (3) studies that explicitly recognize integration as a multidimensional construct, complementary to the technical perspective.

Integration as the scope of the implementation

Studies that characterize integration as the scope of the implementation conceptualize integration as the extent to which the ERP system is implemented

in the different functions and/or the physical locations of an organization. Although some authors have proposed dimensions of integration such as system and business process integration (Gattiker and Goodhue 2005; Ranganathan and Brown 2006), integration has been measured by its functional scope (Hitt et al. 2002; Karimi et al. 2007; Ranganathan and Brown 2006) and/or physical scope (Barki et al. 2005; Cotteleer and Bendoly 2006; Gattiker and Goodhue 2005; Karimi et al. 2007; Ranganathan and Brown 2006).

Functional scope, i.e. the extent of adoption of ERP modules, refers to the range of business functions (accounting, finance, sales, etc.) that share ERP implementation. Greater ERP functional scope is achieved through the implementation of multiple ERP modules, which provides data and process integration across multiple functions and more benefits than a single function implementation (Karimi et al. 2007). Physical scope, i.e. the number of sites that the ERP system can reach, refers to the geographic locations that an ERP project envelops. It has been defined by the number of sites that a project can reach or its breadth, such as departments, divisions, the entire company, and multiple companies (Barki et al. 2005; Karimi et al. 2007; Parr and Shanks 2000; Ranganathan and Brown 2006), the geographic reach, such as regional, national, and global (Karimi et al. 2007), and the number of employees it affects or the depth of the implementation (Barki et al. 2005; Parr and Shanks 2000). This vision of integration in an ERP context could also been seen as the technical aspect of integration, but for clarification purposes, is separated from the next perspective.

Technical perspective of integration

The second stream of research captures mainly the technical point of view of integration. This work focuses on the limited but important aspect of system integration and represents the extent to which different systems are interconnected and can talk to one another (Elbanna 2007; Ranganathan and Brown 2006; Wainwright and Waring 2004; Zaheer and Venkatraman 1994; Zhu and Kraemer 2005). It is the physical linkages of information systems,

subsystems, databases, applications, and communication networks that are deployed by the organization (Wyse and Higgins 1993). Through the exploitation of the capabilities of computers and communication technologies, technical integration allows internal and/or external business processes (Venakatramn and Zaheer 1990) and activities (Paulraj and Chen 2007) to be integrated. It has also been defined with concepts such as electronic integration (Kambil and Short 1994; Venkatraman and Zaheer 1990; Zaheer and Venkatraman 1994), EDI integration (Iacovou et al. 1995; Massetti and Zmud 1996; Swatman et al. 1994; Truman 2000), system integration (Barua et al. 2004; Markus 2000; Swan et al. 1999), back-end integration (Zhu and Kraemer 2005), supplier integration (Zhu and Kraemer 2002), computer integration (Hart and Estrin 1991; Hart and Saunders 1997), and interface integration (Truman 2000). This approach focuses mainly on the technological aspects, solving the connection problems between different devices and the exchange of information between computer applications.

Integration as a complementary dimension of technical integration

The last stream of research focuses on a complementary view of integration. Integration not only comprises the technical/system element previously described, but may also include the social/cognitive and/or business process elements. Given that the first dimension has been explained above, the last two dimensions are the focus of this section.

First, the business process dimension identifies integration as the creation of tighter coordination among the business activities conducted by different individuals, work groups, or organizations so that a unified business process is formed (Bhardwaj et al. 2007; Giachetti 2004; Markus 2000). The objective is to ensure that minimal effort is expended and maximal benefits are derived in the execution of activities (Das 1992). It goes beyond system integration as it does not only assume that the systems are interconnected, but are also able to send information (Huang et al. 2003). Business process integration also allows for greater flow of information among departments and/or value chain trading

partners (Angeles 2008; Bharadwaj et al. 2007; Mendoza et al. 2006; Rai et al. 2006), the standardization of processes within and/or with business partners (Bharadwaj et al. 2007; Elbanna 2007; Massetti and Zmud 1996; Raymond et al. 2009; Volkoff et al. 2005), and support cross-functional business processes (Barnes et al. 2002; Oh et al. 2007; Ranganathan and Brown 2006). This dimension has mainly been studied as a complementary dimension to the system integration dimension. Indeed, business process integration is often cited as a key goal associated with the implementation of information technologies such as ERP (Markus et al. 2000), EDI (Mukhopadhyay and Kekre 2002), or enterprise application integration (Kobayashi et al. 2003). However, business process integration is often not explicitly defined or frequently not differentiated from other forms of integration (Berente et al. 2009) such as data integration, electronic integration, application integration, system integration, and organizational integration (Barki and Pinsonneault 2005; Grant and Tu 2005; Markus 2001; Oh et al. 2007; Saeed et al. 2005; Venkatraman Zaheer 1990). Also, what is known from business process integration often goes by another name such as information integration (Beretta 2004; Themistocleous 2001), operational integration (Elbanna 2007), and systems integration (Wainright and Waring 2004).

Second, as integration also concerns the social actors within the organization who are being affected by the integration capability of information systems, the role and involvement of people have been recognized as well as a dimension of integration (Beretta 2002; Elbanna 2007; El Amrani et al. 2006). The primary issues are ensuring that new systems support the role of users to make their tasks more enriching and productive (O'Sullivan 1992). This means that effective integration also requires the awareness of organizational actors regarding the integrated nature of information systems. The integrative perception that organizational actors have of their activity and processes as it relates to the overall business processes and IT in which they contribute to may offer several benefits. For instance, it may help to better understand the perspective taken by other functions, develop a more collective sense of belonging, and facilitate the

awareness of the interdependencies and information sharing between the various organizational units (El Amrani et al. 2006; Rowe et al. 2005). It has been defined as a dimension of IS integration with concept such as social integration (Elbanna 2007; O'Sullivan 1992; Wainwright and Waring 2004; Waring and Wainwright 2000), cognitive integration (Beretta 2002, 2004), behavorial integration (Lee et al. 2003), and cross-functional overview (El Amrani et al. 2006; Rowe et al. 2005). It has been studied in more depth in the ERP context because such systems break down functional silos and users should have a better understanding of their actions on others' activities and the business processes that run through the different functions of an organization when high level of ERP integration is achieved (Beretta 2004; El Amrani et al. 2006; Rowe et al. 2005). ERP systems may facilitate a cross-functional view of how organizations work, but it is often taken for granted when ERP modules are implemented. Even though some studies have provided theoretical motivation for the importance of the user aspect of integration, few studies have provided empirical evidence of this dimension (El Amrani et al. 2006).

What emerges from these studies is the illustration of the importance of (1) a multidimensional perspective and (2) a module approach of integration that goes beyond the scope of the implementation. First, by looking at ERP integration as being composed of the system, business process, and user dimensions, a better understanding of how and why different degrees of integration are achieved may be provided. Second, the previous conceptualization of ERP integration as the scope may have created an inconsistent and vague understanding of ERP integration. This conceptualization provides some useful understanding of the current state of ERP implementation, but provides limited insights into the actual degree of integration achieved. More specifically, the assumption that integration increases proportionally with the number of modules and/or the number of implementation sites can create inconsistent and vague understanding of integration. For example, should an organization that implements three modules across two divisions have greater integration than another one that implements three modules in one division? Or, is greater ERP

integration achieved when a certain number of modules are implemented? Such a conceptualization of ERP integration neglects the contribution of other forms of integration, as well as the contribution of each module on overall integration. Integration can actually be more complex and dynamic, where different levels of integration may be required between different units/modules, in accordance to their fit with their strategic, business, and technological environment (Kien and Lian 2009). Thus, integration can be different across business units/modules of a same organization and influence the integration at the organizational level differently. In accordance, a conceptualization at the module level based on the system, business process, and user dimensions may be more appropriate to have a fine-grained approach to ERP integration (Kien and Lian 2009).

Theoretical Development

Conceptualizing ERP integration at the module level

The analysis of the literature uncovers support for the definition of the ERP module integration, which is defined here as the *extent to which the components of an ERP module and its users are tightly coupled with relevant business processes, IT applications, and users.* Here, "tightly coupled" describes a system in which ERP modules and IT applications, the business processes, and the users of the ERP modules are not only linked together, but are also dependent upon each other (Orton and Weick 1990). Through integration of modules and processes, the users of various ERP modules develop a unified view of the organization (Sahaym et al. 2007). Finally, since ERP systems are designed to address companies' needs for internal business processes and IS integration, and do not satisfy the need for external integration, ERP module integration is conceptualized here as the integration of systems, business processes, and users internal to the organization (Markus 2000).

In sum, the proposed construct of module-level ERP integration draws from previous literature on IS integration and groups a conceptually close and related set of dimensions that have been suggested or implied by several researchers (see Table 1). ERP integration involves a high-level management of

all integration efforts within an organization where considerations have to be given to the business processes, technological structures, and people. Broadly speaking, this can be aggregated into three distinct areas comprised of not only the business and system integration (Markus 2000), but also user integration (Elbanna 2007; Rowe et al. 2007). As such, it provides a promising approach that can capture the rich and varied nature of ERP integration and enable its assessment. The system dimension captures the physical linkages between the different ERP modules and information systems to allow for data and application sharing. The business process dimension captures the flow of information between business activities in a process. The user dimension captures people's awareness of the transverse nature of the ERP module and their actions on other works. Each dimension is further described below.

Table 1. Definition of research constructs

ERP module Integration	Extent to which the components of an ERP module and its users are tightly coupled with relevant business processes, IT applications, and users.
System Integration	Extent to which different applications and information systems of the business units are tightly coupled.
Data	Extent to which the data that are stored have common data definitions and are consistent across a firm's business units.
Application	Extent to which a business unit's specific modules communicate in real-time with other ERP modules and IS applications
Business Process Integration	Extent to which information flows between business's activities, creating tighter coordination and unified business processes.
User Integration	Extent to which ERP users are aware of the coupled and transverse nature of business processes across different units and the effect their action can have on the work of others ERP users.
Behavorial	Extent to which ERP users are aware of the effect of their actions can have on the work of others ERP users.
Cognitive	Extent to which ERP users are aware of the transverse character of cross-functional business processes of the ERP module.

System integration

The first dimension of ERP module integration is called system integration and refers to the extent to which the different information systems and applications

are tightly coupled (Markus 2000). In other words, the implementation of ERP modules is merely the means chosen to achieve the integration of the enterprise, or at least greater integration of the enterprise (Alsène 1999). The systems put in place contribute to the integration of the enterprise in general, and to the system integration of the enterprise in particular. Thus, system integration is achieved through the application of information technologies such as ERP, and allows data and applications to be shared and accessed for organizational use (Bhatt 2000). Indeed, ERP systems can be used to establish integrated IT infrastructure across internal business units and thus eliminate the need for custom applications to transfer data and support the different activities of the enterprise (Ranganathan and Brown 2006). Furthermore, based on previous work, system integration can be further decomposed into data integration (Berente et al. 2009; Bharadwaj et al. 2007; Bhatt 2000; Giachetti 2004; Goodhue et al. 1992; Huang et al. 2003; Rai et al. 2006) and application integration (Berente et al. 2009; Bhatt 2000; Giachetti 2004; Huang et al. 2003; Rai et al. 2006).

Data integration refers to the extent to which the data that are stored in the ERP module have common data definitions and are consistent across a firm's business units (Rai et al. 2006). The integration goal is data sharing where two or more modules, applications or organizational units exchange data with each other (Giachetti 2004). It involves common definitions of data across functional groups and encoding formats between the systems to be integrated, which form a common core in the work of each user of the ERP module (Alsène 1999; Goodhue et al. 1992; Huang et al. 2003). The users of the ERP module are working on identical data, which may result in more coherent work, reduced reconciliation, errors, and adjustments (Alsène 1999). It is similar to electronic data interchange integration (EDI), in which heterogeneous systems are able to exchange transactions by following a common set of data and communications protocols. Thus, data integration will be enabled by common data definitions for key entities, such as customer and product, as well as automated system for accurate data capture.

Application integration refers to the extent to which a business unit's specific module(s) communicate in real-time with other ERP modules and IS applications. It is concerned with a business unit's ability to interface function-specific applications with each other and involves the electronic linking of autonomous applications (Grant and Tu 2005; Themistocleous 2001). In other words, two distinct ERP modules can interact with each other (Huang et al. 2003). Such interoperability enables the management of cross-functional process dependencies (Rai et al. 2006) and sharing of information (Bhatt and Trout 2005). It ensures that data can be sent from one application to another, i.e. that specific applications from a business unit can interface with other applications in real-time; not whether the data sent can be read or what the content of the information that is actually shared is (Giachetti 2004; Rai et al. 2006). Integrated applications should facilitate the coordination of processes and provide the capability to generate cross-functional data (Bhatt 2000).

Business process integration

The second dimension of ERP integration represents the extent to which information flows between business activities create tighter coordination and unified business processes (Berente et al. 2009; Markus 2000). It requires the integration of business processes including synchronizing business functions and coordinating organizational activities (Hasselbring 2000). It involves the minimization of time associated with the communication of information and coordination between activities of a process and the duplication of efforts across business units (Berente et al. 2009; Markus 2000). It can be achieved through business process reengineering (BPR) or customizing the system and entails information standardization as it leads to tightly coupled business processes.

The functionality provided by an ERP system is specifically intended to link business processes together to improve visibility and information flow (McAfee 2002). However, system integration is not sufficient for fully integrating business processes because different individuals and groups responsible for process activities have different information needs, interpretations, and practices

(Berente et al. 2009). For example, to have information from a new order flow through the entire system and trigger the necessary changes in inventory stock, the different activities of the process need to be integrated. Thus, business process integration deals with the streamlining and amalgamation of business activities and processes and allows the combination of information from many sources (Elbanna 2007; Markus 2000; Rai et al. 2006).

User integration

Integration lies also in collective actions where the shared understanding of business process translates into coordinated and aligned actions across the different parts of an organization (Ghoshal and Gratton 2002). Such integration requires not only integrated IT applications and business process but also the integration of users. Thus, the third dimension of ERP module integration, *user integration,* refers to the users' awareness of the coupled and transverse nature of business processes, i.e. the interdependencies and information sharing between the various modules of the ERP system and the effect of their action on the work of other users of the ERP module (Rowe et al. 2005; El Amrani et al. 2006). It is similar to the concept of business process skills, which represents an understanding of how the business operates and the ability to predict the impact of a particular action on the rest of the enterprise (Stratman and Roth 2002). It can be argued that it is one of the biggest challenges of successful ERP integration (Lee et al. 2003).

The more that business processes and IT applications are integrated, the more that operations are conducted in a cross-functional way. However, it does not mean that users are aware of the integrated nature of ERP or know how everything works together and understand the effects of their actions on the work of others (Rowe et al. 2005). Indeed, there is more to ERP integration than just the physical integration of the systems and business process; the organization and its social actors must behave as a whole (Alsène 1999; Lee et al. 2003). The end result is that people work in a more collaborative way and that links are shaped between the various functional units (Alsène 1999). Thus, the social aspects of

the integration capability of ERP systems are also critical to the implementation of such a system (Elbanna 2007; Lee et al. 2003). User integration deals with the coordination and conduct of the different individuals, work groups, and business units to work together in order to develop integrated processes and be a part of the same integrated organization supported by the ERP (Elbanna 2007). As such, two components have been identified in the literature, namely cognitive and behavorial integration.

Cognitive integration refers to users' awareness of the transverse character of cross-functional business processes. Effective cognitive integration requires that the different users understand the organizational processes, i.e. a broader perspective of their business processes, department, and organization, in addition to appreciating how the ERP module and its applications supports them (Rowe et al. 2005; Volkoff et al. 2005). ERP systems provide users with standardized processes, thus offering cognitive schemes that facilitate coordination (Beretta 2002). However, users have to also understand the cross-functional nature of the ERP module, which may help each user take into consideration solutions that can be mutually satisfactory (Berretta 2004) and may greatly facilitate inter-functional exchanges (Bharadwaj et al. 2007). Thus, users will need to acquire an understanding of the integrated activities in which their own work is embedded (El Amrani et al. 2006).

Behavorial integration refers to users' awareness that their actions can affect the work of others. For instance, an employee entering data must pay careful attention to the task in order to avoid making an error, which could have serious implications not only for him/her, but also for people in other departments. Personal workarounds that individuals use to adjust the system to their own preferences are also likely to have consequences on the work of others. It is similar to the concept of work process understanding previously developed (Jones et al. 2008) in which users understand how to perform their own activities in the ERP environment and how their work activities fit into other work processes. The technical integration of an ERP module can be a success but if the organization and its users are not going to internalize it, the full integration may

not be achieved (Lee et al. 2003). As such, to achieve the maximum integration from an ERP module, system, business process, and user integration need to be considered and achieved.

The relationship between ERP module integration and its dimensions

ERP module integration, being multidimensional, can either be formative or reflective (Law et al. 1998). In reflective constructs, causality is believed to flow from the construct to its measures, while in formative constructs, the measures are believed to precede the construct and cause it (Edwards 2001; Petter et al. 2007). The choice of a formative conceptualization of ERP module integration was made based on Jarvis et al.'s (2003) recommendations, who suggest that four major criteria should be observed to model formative constructs: (1) the direction of causality must be from indicators to constructs, (2) the indicators need not be interchangeable, (3) co-variation among indicators is not necessary, and (4) the nomological net of indicators can be different, i.e. the indicators are not required to have the same antecedents and consequences (Jarvis et al. 2003). In the present case, it is the complementary nature that emanates from the combined integration of those three conceptually-distinct components that is used to define the overall degree of ERP module integration. Since system, business process, and user integration can influence the integration of an ERP module in different ways, these dimensions will not necessarily be correlated, suggesting that the construct of ERP module integration is an aggregate or formative construct. More specifically, change in the dimensions cause changes in the ERP module integration construct, thus eliminating specific dimension risks changing the domain of the construct (Jarvis et al. 2003). Also, the integration of one component does not imply that the others will be integrated and each component contributes in its own way to shape the overall level of ERP module integration. Finally, these dimensions will have different antecedents. For example, data and applications are expected to influence system integration, while cognitive and behavorial integrations are expected to influence user integration. Thus, a formative conceptualization appears to be appropriate.

Two of the dimensions of ERP module integration, system and user integration, are also viewed as formative constructs, both composed of two dimensions: data and application integration formed system integration and cognitive and behavorial integration formed user integration. Business process integration is viewed as a reflective construct. Finally, the measures for each sub-dimension (data, application, cognitive, and behavorial integration) are viewed as reflective indicators.

Method

Development of the ERP Module Integration Construct

To measure ERP module integration, a scale was developed by following a series of steps based on previous guidelines for instrument development and validation (Churchill 1979; Moore and Benbasat 1991). First, initial items were developed from the literature and their measurement properties were tested on a small scale. Finally, a full-scale test of measurement properties and the structural model were conducted. Each of these procedures is described below.

Scale development procedures

The first step consisted of developing survey items based on previous empirical and theoretical literature (See Appendix B). Using this model as a guide, the items were developed based on previous research and supplemented with new items that capture the different aspects of the ERP module construct and its dimensions (See Appendix D). More specifically, new items were generated for system integration, while all items for data and application integration were adapted from existing literature (Barua et al. 2004; Langdon 2006; Rai et al. 2006). For business process integration, four items were adapted from existing literature to which one item was added (Bharadwaj et al. 2007, Oh et al. 2007, Paulraj and Chen 2007). Finally, all items for user integration and its sub-dimensions, cognitive and behavorial integration, were developed as only few authors have looked at this dimension (El Amrani et al. 2006; Rowe et al. 2005).

Second, the items generated were submitted to two rounds of a card-sorting test (Moore and Benbasat 1991). For each round, 10 different PhD students in information systems grouped the list of items into pre-defined categories. For the first round, 27 items related to ERP module integration were used for the card-sorting test. However, after the first round, it was necessary to modify some items in order to improve the clarity and comprehension of the words used and some items were deleted or added at this stage. More specifically, items that did not show average agreement above 0.80 were deleted or modified. A total of eight items were deleted and two were modified. Additionally, three items were added: one for behavorial integration, one for cognitive integration, and one for business process integration. For the second round, the business process performance construct and its dimensions were eliminated from the card sorting since most of the items came from existing literature and resulted in satisfactory classification the first time. A total of 22 items were sent to card sorting and four were slightly modified after the second card sorting. The final sorting resulted in a satisfactory classification of the items into the different dimensions of ERP module integration, i.e. all items showed an average agreement above 0.80. Appendix C shows the results for each round as well as the items that were deleted or modified. Furthermore, the multiple indicators multiple causes (MIMIC) approach for assessing formative indices was used to assess ERP module integration (Diamantopoulos and Winklhofer 2001). This approach requires that construct dimensions also be assessed with reflective indicators. Consequently, following previous work (Barki et al. 2007), two reflective indicators were developed for system integration, user integration, and ERP module integration. Finally, five items were deleted. The final instrument consisted of 3 reflective items for data integration, application integration, cognitive integration, and behavorial integration; 5 reflective items for business process integration; and two reflective items for system integration, user integration, ERP module integration, and business process performance.

Third, a web-based survey was developed and pre-tested by three managers involved in previous ERP implementations in order to improve face

validity and make sure that the items were relevant to managers of existing organizations. Based on the results, the questionnaire was further modified. The goal was to make the questionnaire more valid and reliable by clarifying, rephrasing, or eliminating problematic, obscure, and poorly answered items. These changes did not affect the overall structure.

The revised questionnaire (see Appendix 2 at the end of the thesis) was then distributed to managers from an e-mail contact list provided by APICS (The Association for Operations Management) Education and Research Foundation. An initial e-mail sent by APICS explained the purpose of the study and a link to an external website was provided. This website explained the importance of their participation and the link to the survey and promised them a summary of the research findings as well as a chance to enter to win a prize. One follow-up e-mail was sent by APICS a week after the initial e-mail. In total, 146 surveys were returned but 75 incomplete surveys were removed as well as 3 aberrant responses with a uniform answer to the entire set of questions were excluded. A total of 68 fully answered responses were used for the analysis.

The sample included respondents from 8 different industries, with almost 70% from the manufacturing industry. The respondents were involved in 17 different types of modules from different package vendors, with 18% implementing a MRP module and 31% a SAP vendor. Almost all respondents had previous experience with an ERP implementation, with 30% of the respondents previously involved in more than 5 ERP implementation projects. Furthermore, 78% of the respondents were male, more than 88% were between 30 and 59 years of age, and more than 84 % held at least a bachelor's degree. Thus, even though a non-random sampling approach was used, the sample contained a variety of industries, organizations, and modules implemented (See Table 2). Two checks for nonresponse bias were performed. First, incomplete surveys were compared to complete surveys. Second, late respondents (after the follow-up e-mail was sent) were compared with early respondents (after the initial mailing). No systematic differences were identified in either check, suggesting the absence of response bias.

Table 2. Demographics of Participants

Demographics		Frequency	Percentage
Gender	Men	53	77.9%
	Women	10	14.7%
	Not specified	5	7.3%
Manager's Role in the ERP implementation	Project Manager	14	20.6%
	Business Analyst	3	4.4%
	Integrator	6	8.8%
	Knowledge Worker	5	7.4%
	Super user	20	29.4%
	Team leader	2	2.9%
	Consultant	3	4.4%
	Program Director	2	2.9%
	More than 1 role	11	16.2%
	Others (not specified)	2	2.9%
Job Title	Functional Manager	20	29.3%
	Department manager	30	44.1%
	Senior manager	7	10.3%
	Consultant	3	4.3%
	Integrator	1	1.5%
	Research Analyst	1	1.5%
	Others (not specified)	6	8.8%
Tenure in Organization	Less than 2 years	6	8.8%
	2-5 years	19	28%
	6-10 years	15	22.1%
	10-20 years	11	16.1%
	More than 20 years	10	14.7%
	Not specified	7	10.3%
Manager's Previous Experience with ERP Implementation (# of implementation)	None	1	1.5%
	1	7	10.3%
	2-4	31	45.6%
	More than 5	14	20.5%
	More than 10	6	8.8%
	Not specified	9	13.3%
Education	High school degree	5	7.4%
	Collegial/technical degree	6	8.8%
	Bachelor degree	25	36.8%
	Master's degree	26	38.2%
	Not specified	6	8.8%
Age	20-29	0	0%
	30-39	12	17.6%
	40-49	24	35.3%
	50-59	24	35.3%
	60+	3	4.4%
	Not specified	5	7.4%

Results

Structural equation modeling (SEM) was adopted as the main data analysis method. More specifically, the usable data collected were analyzed using EQS for Windows program (Version 6.1), which places less stringent assumptions on the multivariate normality of the data (Byrd and Turner 2000). Following previous recommendations (Barki et al. 2007; Byrd and Turner 2000; Segars and Grover 1998), the three dimensions were evaluated in isolation, with a nomological net, and then as a collective network. This procedure provides evidence of measurement efficacy and also reduces the likelihood of confound effects in structural equation modeling.

To validate each measurement model, reliability and validity analyses were performed. Reliability was assessed based on Cronbach's alpha (CA) and composite reliability (CR), which values should exceed the recommended threshold value of 0.7 (Nunnally 1978). Convergent validity was confirmed by examining both the average variance extracted (AVE) and the factor loadings of the indicators associated with each construct. The AVE values should be above the threshold value of 0.5 (Fornell and Larcker 1981) and loadings of items above a cutoff of 0.5, given the exploratory nature of this research (Byrd and Turner 2000). Finally, discriminant validity was assessed by comparing the square root of the AVE for each construct against the inter-construct correlation estimates, which requires that the diagonal elements be greater than the off-diagonal elements (Fornell and Larcker 1981).

Consistent with structural equation modeling recommendations (Winklhofer and Diamoantopoulos 2002), overall fit was assessed based on normed chi-square (χ^2/d.f.), which should be <2.00; NFI (normed-fit index), NNFI (non-normed fit index), CFI (comparative-fit index), and GFI (goodness-of-fit index), which should be above 0.90, RMSEA (root mean-square error of approximation) <0.06, and SRMR (standardized root mean-square residual) <0.08. Missing data were treated via listwise deletion. Appendix D provides the

questionnaire items as well as the reliabilities and descriptive statistics and Appendix E provides the correlations matrices and measurement statistics.

Assessment of system integration

Estimation of the measurement model with three indicators for each dimension of system integration resulted in a good fit statistic with all indicators above their threshold number ($\chi^2 = 15.289$; df = 14; p = 0.359; NFI = 0.96, NNFI = 0.99, CFI = 0.99, GFI = 0.95; SRMR = 0.04; RMSEA = 0.04). Moreover, none of the standardized residuals (largest = 1.22) exceeded a value of |2.58| which would indicate a specification error (Sharma 1996). All indicators were significant with reliability of 0.84 (CA) and 0.79 (CR) for data integration, 0.75 (CA), and 0.79 (CR) for application integration, and 0.85(CR) and 0.85 (CR) for system integration. The AVE was above 0.50 for all constructs and the square root of the AVE for each construct was greater than the off-diagonal elements (see Appendix D and E). All standardized loadings of items were above a cutoff of 0.30 (see Table 3). Finally, as hypothesized and shown on Figure 1, the paths between data integration and system integration and between application integration and system integration were positive and significant ($\beta_1 = 0.43$; t-value 1.83 and $\beta_2 = 0.48$; t-value = 2.032), explaining 75% of the variance in system integration.

Although the major focus of this essay is to develop and measure a robust ERP module integration construct, it is also important to show that this construct predicts the kinds of outcomes one would expect from integrated ERP modules. Demonstrating predictive validity is one way to test for nomological validation, which examines a measure in relation to other theoretically related constructs, and is best assessed within specific theoretical networks (Venkatraman, 1989). In order to provide a sound conceptualization of ERP module integration, its nomological validity is established by looking at its effect on business process performance. The effect of ERP integration has been demonstrated at both the firm and process level. At the firm level, productivity, stock market valuation, share holder returns, and firm performance have been measured (Hitt et al. 2002; Ranganathan and Brown 2006). At the process level, operational performance,

task efficiency, coordination improvement, data quality, and business process performance have been assessed (Cotteleer and Bendoly 2006; Gattiker and Goodhue 2005; Karimi et al. 2007). The process-oriented perspective is useful for identifying various ways ERP module integration can provide business value since first-order effects occur at the operational level (Barua et al. 1995; Tallon 2007). Previous research has shown that improving business process performance can be achieved by implementing an ERP (Karimi et al. 2007).

Table 3. Measurement properties of system integration

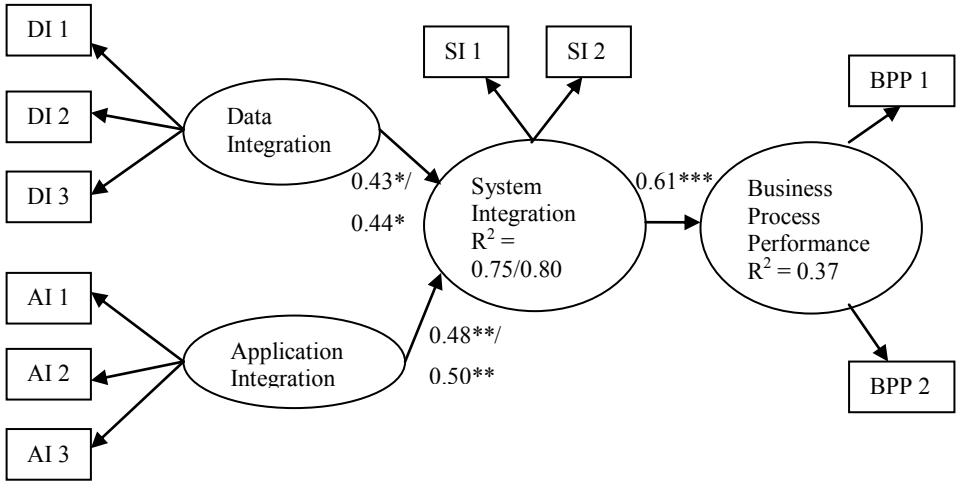
Item	Mean	Standard Deviation	Standardized Factor loading	t-value	p-level
Data Integration					
DI 1	2.11	.1323	.867/.850*	4.97/5.11*	P<0.001
DI 2	1.89	.8890	.747/.739	6.89/7.17	P<0.001
DI 3	2.13	.9493	.612/.632	NA	NA
Application Integration					
AI 1	1.84	.8530	.856/.864	4.43/4.25	P<0.001
AI 2	1.95	.9131	.533/.510	NA	NA
AI 3	2.16	.9442	.812/.815	4.33/4.16	P<0.001
System Integration					
SI 1	2.40	.8955	.876/.852	NA	NA
SI 2	2.32	.8641	.848/.845	8.09/8.04	P<0.001
Business process Performance					
BPP 1	2.48	.8601	.983	NA	NA
BPP 2	2.50	.9200	.978	16.337	P<0.001

*The first value reflects the values for the model without performance and the second value, the model with performance.

Applying the above idea to the system integration dimension, the model was estimated with system integration hypothesized to influence business process performance, which is assessed as a reflective construct with two items. Estimation of the initial measurement model produced good-fit parameters (χ^2 = 35.150; df = 29; p = 0.1997; NFI = 0.94, NNFI = 0.98, CFI = 0.99, GFI = 0.91; SRMR = 0.06; RMSEA = 0.056). The largest standardized residuals (1.59) did not exceed the threshold value of |2.58|. Estimation of the model indicated that all coefficients were significant (see Table 3). Values for composite reliability (CR) and average variance extracted (AVE) were all above the recommended threshold value and the square root of the AVE for each construct was greater than the off-

diagonal elements (see Appendix D and E). Finally, as hypothesized, the paths between data integration and system integration, between application integration and system integration, and between system integration and business process performance were positive and significant ($\beta_1 = 0.44$; t-value 1.84, $\beta_2 = 0.50$; t-value = 2.047; and $\beta 3 = 0.61$; t-value = 5.097), explaining 80% of the variance in system integration and 37% of the variance in business process performance (see Figure 1).

Figure 1. System integration



Note. 1st number without Business Process Performance (BPP); 2nd number with BPP

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

Assessment of business process integration

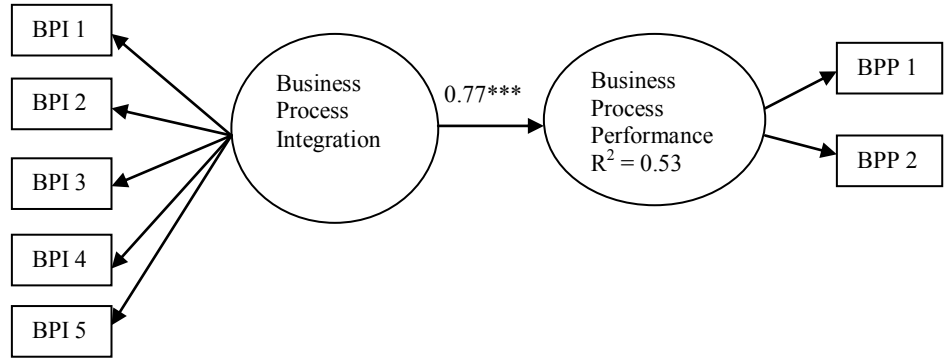
The measurement model for the business process integration dimension resulted in a good fit for the model (χ^2= 3.671; df = 5; p = 0.597; NFI = 0.98, NNFI = 0.99, CFI = 0.99, GFI = 0.98; SRMR = 0.02; RMSEA = 0.00). None of the standardized residuals (largest value of 0.46) exceeded a value of |2.58|. All indicators were significant with reliability of 0.91 (see Appendix D). Standardized factor loadings (see Table 4), composite reliability (0.91), and average variance extracted (0.66) were all above their recommended threshold values. Finally, the square root of the AVE for each construct was greater than the off-diagonal elements (see Appendix D and E).

Table 4. Measurement properties of business process integration

Item	Mean	Standard Deviation	Standardized factor loadings	t-value	p-level
Business Process Integration					
BPP 1	2.35	.8423	.739/.745	NA	NA
BPP 2	2.41	.8506	.824/.858	6.75/7.07	P<0.001
BPP 3	2.03	.6685	.767/.784	6.26/6.43	P<0.001
BPP 4	2.43	.8520	.882/.826	7.24/6.75	P<0.001
BPP 5	2.51	1.01	.853/.819	6.99/6.69	P<0.001
Business process Performance					
BPP 1	2.46	.9695	.973	NA	NA
BPP 2	2.47	.9372	.987	20.91	P<0.001

Estimation of the measurement model (see Figure 2) with business process integration hypothesized to influence business process performance resulted in satisfactory-fit parameters with the exception of RMSEA ($\chi^2 = 22.641$; df = 12; p = 0.031 NFI = 0.95, NNFI = 0.96, CFI = 0.98, GFI = 0.92; SRMR = 0.025; RMSEA = 0.115). None of the standardized residuals (largest value = 0.76) exceeded a value of |2.58|. As expected, the path between business process integration and performance was significant ($\beta = 0.77$; t-value 6.11) explaining 59% of the variance in performance (see Figure 2). Standardized factor loading were all significant and above 0.30 (Table 4) and Cronbach's alpha above 0.70 for both business process integration and business process performance (see Appendix D). Composite reliability for business process integration and business process performance was respectively 0.90 and 0.98 and the average variance extracted respectively 0.65 and 0.98, well above the recommended value (see Appendix E). Finally, the square root of the AVE for each construct was greater than the off-diagonal elements (see Appendix E). Along with goodness-of-fit statistics, these results provide nomological validity evidence for the business process integration dimension.

Figure 2. Business process integration



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

Assessment of user integration

Estimation of the measurement model for user integration produced good-fit parameters ($\chi^2 = 19.894$; df = 15; p = 0.176; NFI = 0.97, NNFI = 0.98, CFI = 0.99, GFI = 0.93; SRMR = 0.03; RMSEA = 0.07). None of the standardized residuals (largest value = 0.084) exceeded a value of |2.58|. All indicators were significant (see Table 5) with reliability of 0.94 (CA) and 0.94 (CR) for cognitive integration, 0.93 (CA), and 0.93 (CR) for behavorial integration, and 0.90 (CA) and 0.90 (CR) for user integration (see Appendix D and E). The AVE was 0.83, 0.81, and 0.82, respectively, for the three constructs, and the square root of the AVE for each construct was greater than the off-diagonal elements (see Appendix E). As hypothesized, the paths between behavorial integration and user integration and between cognitive integration and user integration were positive and significant ($\beta_1 = 0.21$; t-value = 2.51, and $\beta_2 = 0.81$; t-value = 7.28), explaining 92% of the variance in user integration (see Figure 3).

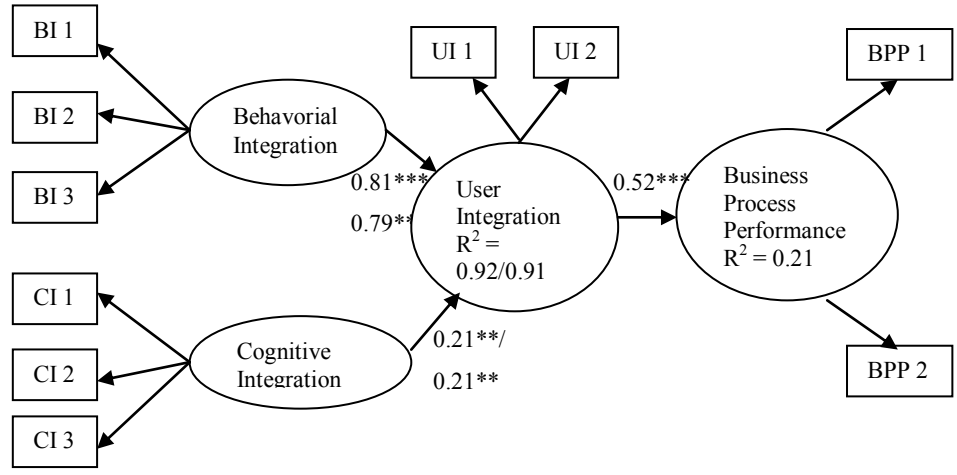
Estimation of the measurement model (see Figure 3) with user integration hypothesized to influence business process performance resulted in good-fit parameters ($\chi^2 = 29.84$; df = 29; p = 0.421; NFI = 0.96, NNFI = 0.99, CFI = 0.99, GFI = 0.92; SRMR = 0.036; RMSEA = 0.02). None of the standardized residuals (largest value = 0.089) exceeded a value of |2.58|. All indicators were significant (see Table 5) with reliability of 0.94 (CA) and 0.94 (CR) for cognitive

integration, 0.93 (CA) and 0.93 (CR) for behavorial integration, 0.90 (CA) and 0.90 (CR) for user integration, and 0.98 (CA) and 0.98 (CR) for business process performance (see Appendix D and E). The AVE was 0.83, 0.81, 0.82, and 0.96, for respectively the three constructs, and the square root of the AVE for each construct was greater than the off-diagonal elements (see Appendix E). As hypothesized, the paths between behavorial integration and user integration, between cognitive integration and user integration and between user integration and business process performance were all positive and significant ($\beta_1 = 0.21$; t-value = 2.53, $\beta_2 = 0.79$; t-value = 7.25, and $\beta_3 = 0.52$; t-value = 3.89), explaining respectively 91% and 21% of the variance in system integration and business process performance (see Figure 3). Along with goodness-of-fit statistics, these results provide nomological validity evidence for the user integration dimension.

Table 5. Measurement properties of user integration

Item	Mean	Standard Deviation	Standardized Factor loadings	t-value	p-level
Behavorial Integration					
BI 1	2.40	.9946	.869/.870	NA	NA
BI 2	2.60	.9641	.938/.938	11.5/11.5	P<0.001
BI 3	2.62	.9840	.896/.896	10.45/10.45	P<0.001
Cognitive Integration					
CI 1	2.25	.9203	.916/.916	NA	NA
CI 2	2.29	.9472	.917/.916	12.52/12.52	P<0.001
CI 3	2.46	.9687	.906/.906	11.93/11.94	P<0.001
User Integration					
UI 1	2.57	.9822	.859/.861	NA	NA
UI 2	2.46	.9531	.946/.949	11.27/11.41	P<0.001
Business process Performance					
BPP 1	2.46	.9695	.990	NA	NA
BPP 2	2.48	.9372	.962	12.59	P<0.001

Figure 3. User integration



Note. 1st number without BPP; 2nd number with BPP

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

Assessment of ERP module Integration as an Aggregate Construct

To assess ERP module integration as an aggregate second-order construct formed by three dimensions, reflective indicators were used for each dimension as well as ERP module integration and business process performance (Figure 4). More specifically, the aggregate second-order ERP module integration construct formed by three dimensions was assessed with each dimension measured with two reflective items. For business process integration, the first two items were chosen while for the other constructs, items previously used in the previous analysis were used. The reflective measurement model exhibited a good-fit parameters (χ^2 = 35.520; df = 27; p = 0.126; NFI = 0.94, NNFI = 0.97, CFI = 0.98, GFI = 0.91; SRMR = 0.04; RMSEA = 0.06). None of the standardized residuals (largest value = 0.115) exceeded a value of |2.58|. All indicators were significant (see Table 6) with a reliability of 0.85 (CA) and 0.85 (CR) for system integration, 0.77 (CA) and 0.77 (CR) for business process integration, 0.90 (CA) and 0.90 (CR) for user integration, 0.78 (CA) and 0.72 (CR) for ERP module integration, and 0.98 (CA) and 0.98 (CR) for business process performance (see Appendix D and E). The AVE was respectively 0.74, 0.64, 0.82, 0.56, and 0.96

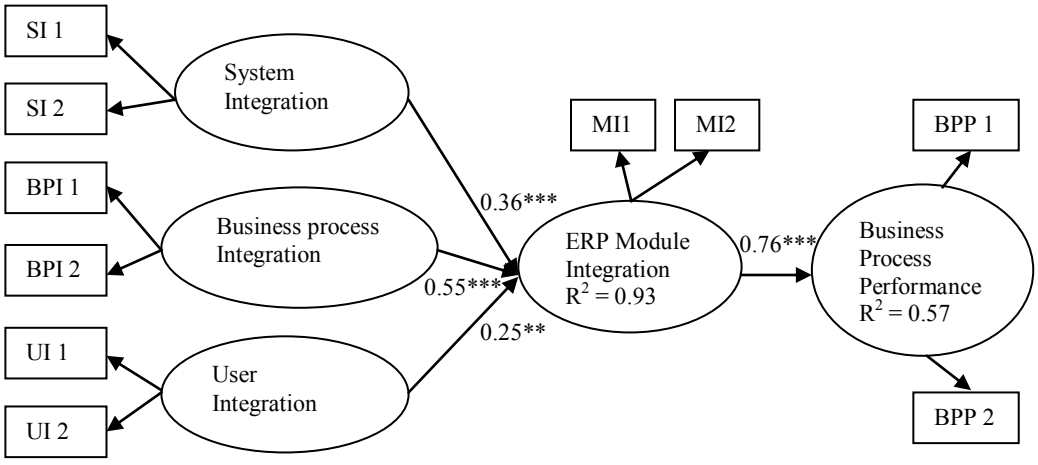
for respectively the five constructs (see Appendix E). However, the value of the square root of the AVE for ERP module integration was lower than the value of one of the off-diagaonal elements (business process integration), suggesting limited discriminant validity for this construct. Overall, the analysis of the reflective models yielded consistent results, supporting the conceptualization of ERP module integration as an aggregate, second-order construct.

Table 6. Measurement properties of reflective model

Item	Mean	Standard Deviation	Standardized Factor loadings	t-value	p-level
System Integration					
SI 1	2.40	.8955	.836	NA	NA
SI 2	2.32	.8641	.887	6.90	P<0.001
Business Process Integration					
BPI 1	2.35	.8423	.740	NA	NA
BPI 2	2.41	.8506	.848	6.02	P<0.001
User Integration					
UI 1	2.57	.9822	.947	NA	NA
UI 2	2.46	.9531	.861	6.98	P<0.001
ERP Module Integration					
MI1	2.38	1.0226	.805	NA	NA
MI2	2.59	1.0256	.685	5.94	P<0.001
Business process Performance					
BPP 1	2.46	.9695	.987	NA	NA
BPP 2	2.48	.9372	.974	20.60	P<0.001

Estimation of the structural model indicated that the second order coefficients of user integration, business process integration and system integration were significant as well as the path between ERP module integration and business process performance ($\beta_1 = 0.36$; t-value = 2.72, $\beta_2 = 0.55$; t-value = 3.24, $\beta_3 = 0.25$; t-value = 2.38, and $\beta_4 = 0.76$; t-value = 6.64). The model explained 93% of the variance in ERP module Integration, which in turn explained 57% of the variance in business process performance, providing nomological validity for the reflective model.

Figure 4. Reflective model of ERP module Integration



* p < 0.05; ** p < 0.01; *** p < 0.001

Common method bias

Common method biases (CMBs) are often cited as potential problems of self-reported survey studies that rely on responses in a cross-sectional, single setting. Two statistical analyses were performed as robustness check to ensure the validity of the results. First, the Harman's one-factor test was carried where issues of CMB would result in either a single factor from a factor analysis or one latent factor would account for all manifest variables. Results of a single exploratory factor analysis indicated that 5 factors with eigenvalues greater than 1.00 combined account for 76.5% of total variances, while a factor with the greatest eigenvalue explains 21.2%. In addition, following previous recommendations (Podsakoff et al. 2003; Liang et al. 2007), an additional technique by which possible effects of an unmeasured latent methods are control for was employed. A first-order latent method factor was added to the reflective model of Figure 4 with all items used to measure the constructs of the model as indicators of the method factor. The fit indices of the model with the method factor included were worse than those of Figure 4 (χ^2= 16.954; df = 4; p = 0.002;

RMSEA = 0.229). This indicates that method bias is unlikely to have significantly affected the study results.

Discussion

This paper develops a measure of ERP module integration. The model states that ERP module integration is represented by system, business process, and user integration. The ERP module integration instrument demonstrated strong reliability and discriminant validity for the three separate dimensions of integration. Tests of nomological validity showed the expected pattern of relationships between ERP module integration and business process performance.

Research on ERP has demonstrated the importance of integration in achieving performance gains. However, these studies have focused on the scope of the implementation at the organizational level as a measure of ERP integration, making it challenging to differentiate between different degrees of integration and assuming that all business units integrate the same way. By looking at ERP integration as a multidimensional construct at the module level, the reasons why and how different degrees of integration are achieved for firms implementing the same ERP can be better understood.

Contributions

This study offers three contributions to the existing body of knowledge about the integration of ERP. First, it develops and provides empirical support for a theoretically sound conceptualization of a finely conceived construct of ERP integration at the module level. By including system, business process, and user integration as its dimensions, the ERP module integration construct represents an initial step in the conceptualization and measurement of integration and addresses an important limitation of past conceptualizations of ERP integration: the capability to distinguish between different degrees of integration for the same ERP system.

Second, another important contribution of this research is the quantitative appraisal of the ERP module integration construct on business process

performance. A better-defined and operationalized construct allows for the prediction and explanation of a number of implementation outcomes such as business process performance and benefits, as the present study's findings have indicated.

Finally, the ERP module integration construct extends previous conceptualization of integration in the IS literature, which tends to view integration as either the integration of the system alone, or with the business process. By exploring the dimensions of ERP module integration, this study provides guidance to organizations on ways to gain value from integrating ERP modules. More specifically, the systems, business processes, and users are all important components of integration and influence the benefits obtained from ERP systems.

Study limitations and further research

The measurement instrument developed in this study, while based on past research, should be considered as a first iteration and needs to undergo further refinement and testing to ensure that the complete domain of the construct is covered and improve its efficacy in ERP studies. In addition, the instrument could be used in a longitudinal study to investigate differences in levels of integration over time, between industries, between sectors (private and public), and between organizational units. Additionally, the relationship between ERP module integration and its antecedents, contexts, and consequences would contribute greatly to the current body of knowledge on ERP. For instance, the relationship between ERP module integration and other outcomes such as the work of ERP users could be further examined.

Furthermore, ERP systems are designed to address companies' needs for internal data and process integration. They do not satisfy companies' need for external data and process integration. Consequently, companies seeking tighter coordination with customers and suppliers must integrate their ERP systems with other applications and technologies (Markus 2001). More specifically, other packaged software such as customer relationship management (CRM), supply

chain management (SCM) and others, which integrate processes within and between organizations, may also benefit from the result of this study in terms of developing benefits from packaged software implementation (Shang and Seddon 2007). Thus, future research could look at the integration of ERP with other applications and technologies.

Some limitations of the present study should be noted. The study suffers from some of the general limitations of survey research such as respondent bias and perceptual scales. The use of single informants was less than ideal. However, the use of robustness analyses suggested that the associations posed in the theoretical model were not driven purely by perceptual or halo effects (not prone to common method bias). Another limitation is that the number of ERP users who were involved in more than one implementation was overly represented in the study sample. This suggests that it could have influence the perceived integration of the ERP module and the ERP module integration construct should be examined in other contexts as well, i.e. when ERP users have no experience with an ERP implementation.

Conclusion

This paper has proposed a complementary conceptualization and measurement of ERP module integration and suggested three dimensions, namely, system, business process, and user integrations. This view enables a fine grained categorization of ERP module integration and provides a tool that can be used to better estimate its degree. This paper also opens new research avenues that will hopefully stimulate the interest of scholars and practitioners working on the impact of ERP implementation on business process performance. While it may be possible for all firms to acquire the latest ERP systems, results indicate that not all firms are equally successful in extracting the full potential of these systems. For companies that can seize and master the challenges of developing superior integrated capability, tremendous performance gains can be achieved.

References: (see end of thesis)

Appendix A: Studies that Examine Integration in IS Research

Authors/ Underlying literature	Conceptualization	Dimensions referring to Integration
View of Integration as the Scope of the Implementation		
Massetti and Zmud (1996) EDI	Electronic document integration: Extent of electronic document integration and exchange within the function and within the organization.	Depth: Extent to which a firm's business processes are intertwined with those of its trading partners through EDI connections. Breadth: Extent to which a firm had developed EDI connections with each of its trading partners. Volume: Extent to which a firm's document exchanges are handled through EDI connections. Diversity: Extent to which different types of a firm's business documents are handled through EDI connections.
Williams et al. (1998) EDI	EDI participation: NA	Range: % of trading partners linked via EDI. Width: Extent to which firms use EDI for multiple purposes. Depth: % of data processing done via EDI.
Hitt et al. (2002) ERP	Functional integration: extent of adoption, which modules were adopted.	NA
Barki et al. (2005) ERP	ERP implementation Breadth: willingness of an organization to link or integrate its different functional units within or across different geographic regions.	NA
Gattiker and Goodhue (2005) ERP OIP	Integration: NA	Data Integration: NA Process Integration: NA Physical scope: NA
Volkoff et al. (2005)	Integration effects	Physical scope: Functional scope:
Cotteleer and Bendoly (2006) ERP	NA	Physical scope: NA
El Amrani et al. (2006)	Cross-functional overview of the firm	Functional scope
Ranganathan and Brown (2006) ERP	Organizational Integration: extent to which distinct and interdependent components constitute a unified whole.	Technical: integrated and standardized IT infrastructure across internal organizational unit. Business: support cross-functional business processes.
Karimi et al (2007)	Extent of ERP implementation: ERP functional scope,	Functional: implementation of multiple or cross-functional ERP

ERP	organizational scope, and geographic scope.	modules and provides data and process integration.. Organizational: organizational locations that the ERP can reach and specifies process integration. Geographic: global reach of the ERP.
View of Integration as System Integration		
Burbidge et al. (1987) CIM	Integration: joining together to make one, i.e. a whole.	NA
Hart and Estrin (1991) ION	Internal Computer Integration: NA	NA
Bergeron and Raymond (1992) EDI	Integration: Level of diffusion of EDI inside and outside the organization	Internal: Variety of applications interconnected through EDI. External: Various types of trading partners.
Goodhue et al. (1992) Information Processing Theory	Data Integration: use of common field definitions and codes across different parts of the organization.	NA
Wyse and Higgins (1993) MIS	IS integration: Interconnection of organizational members with information that reflects the strategic thrust of the organization and the exigencies of its competitive survival.	Data: relevancy of the information that is collected, processed, and disseminated in throughout the organization. Technical: physical linkage of IS and subsystems that are used by the organization.
Kambil and Short (1994) EDI	Electronic Integration: the use of IT to reengineer key business processes and business relations.	NA
Premkumar et al. (1994) EDI DOI	Electronic Integration: using the technology in a comprehensive and integrated manner to support high-level of organizational work and widespread transfer of the technology to other system applications within the organization.	Internal diffusion: Extent of integration of EDI in organizational activities. External diffusion: Extent to which firm is successful in linking with external partners and converting its external transaction documents into electronic form.
Srinivisan et al. (1994) EDI	EDI integration: electronically receive information from suppliers/vendors and directly map it into internal information systems.	Information systems: NA
Swatman et al. (1994) EDI	EDI System Integration: NA	Internal: integration of information received from external sources with existing organizational systems and practices Integration of the organizational systems and practices themselves, which can change the entire structure of the organization.

Zaheer and Venkatraman (1994) EDI	Electronic Integration: vertical quasi-integration achieved through the deployment of computer and communication systems between relevant actors in the adjacent stages of the value chain.	NA
Iacovou et al. (1995) EDI	EDI Integration: process during which a firm alters its business practices and applications so that they interface with its EDI applications.	Internal: Variety of applications interconnected through EDI. External: Number of trading partners.
Hart and Saunders (1997) EDI	Computer Integration: NA	NA
Noori and Mavaddat (1998) System modelling	Enterprise Integration: establishment of an IS infrastructure within organization as well as its external sources of influence, in order to facilitate the flow of information and sharing of information.	NA
Alsene (1999)	Integration of the enterprise: action of forming an ensemble, a coherent whole, of the various administrative units that make up the enterprise, each of which assumes certain functions.	Computer integration of the enterprise (type of integration): integration of the enterprise achieved through the application of IT. Integrating system: computer system which is utilized jointly by members of different functional units.
Brandyberry et al. (1999) CIM	Organizational Integration: degree to which the production processes interface effectively with other functional systems and provide high quality, timely production-related information to organizational decision makers	NA
Swan et al. (1999) MRP	System integration: NA	NA
Bhatt (2000) BPI	IS Integration: extent to which data and applications through different communication networks can be shared and accessed for organizational use.	Data: extent to which organizations can share a number of databases for coordinating their activities. Communication networks: Extent to which different IS can communicate with other.
Chatfield and Yetton (2000) EDI	EDI Integration: Integration with internal strategic IS by the adopter.	NA
Chiang et al. (2000) Database	Database Integration: combination of database reverse engineering and the integration of semantics, schemas, and instances.	NA

Truman (2000) EDI	Integration: NA	Internal:. Integration among the internal systems. Interface: Integration between EDI systems and internal systems
Dan et al. (2001) E-commerce	Business-to-business integration: NA	Back-end integration: NA
Christiaanse and Venkatraman (2002)	Electronic integration: NA	NA
Mukhopadhyay and Kekre (2002) EDI	Electronic Integration: NA	NA
Zhu and Kraemer (2002) E-business RBV DC	Supplier integration: electronic linkages to integrate suppliers via information sharing.	NA
Lee et Lim (2003) EDI	Integration: extent to which data could be directly entered into internal applications without additional processing.	NA
Barua et al. (2004) RBV	System Integration: Extent to which a firm integrates its IT systems to provide visibility to customer and supplier data and to allow online information sharing and transaction execution across the value chain.	NA
Zhu (2004) RBV E-business	Back-end Integration: Degree of information integration with suppliers.	NA
Bhatt and Troutt (2005) BPI	IS Integration: integrated technology that allows sharing of information applications.	Data: data standards and logical coding schemes. Communication network: extent to which different IS can communicate with other IS to coordinate present and future activities, which depends on connectivity and flexibility.
Hobday et al. (2005) RBV	System Integration: capabilities which enable firms to define and combine together all the necessary inputs for a system and agree on a path of future development.	NA
Saeed et al. (2005) Operations IS	Integration	External Integration (system integration): electronic linking of various business functions and bidirectional information flow. Internal Integration (Control): Extent to which IS internal to the firm are integrated.
Zhu and Kraemer (2005)	Back-end Integration (Technology): links web	NA

e-business RBV	applications with back-office databases and facilitates information sharing along the value chain.	
Langdon (2006) IS Capabilities	IS integration: extent to which IT components are blended into a functional whole or a unified IS.	Data integration: NA Application integration: NA
Stefanou and Revanoglou (2006) ERP	System Integration: integration between the sub-systems of ERP software or between best-of-breed ERP systems supporting processes.	NA
Ward and Zhou (2006) Manufacturing	IT Integration: NA	Internal: connects different functions in a firm. External: IS that connects a firm with its suppliers and customers.
Zhu and Kraemer (2006) TOE E-business	Technology Integration: degree of inter-connectivity among back-office IS and databases inside the firm and those externally integrated with suppliers' ES and databases.	NA
Grover and Saeed (2007) IOS Manufacturing RDT	Interoganizational System Integration: Extent to which the systems shared by two or more firms are integrated to facilitate access to information residing in either firm.	NA
Kurokawa et al. 2008 EDI	EDI Integration: Extent to which data could be directly entered into internal applications without additional preprocessing between sellers and buyers.	NA
Chang et al. (2009) Assimilation	Information Integration: extent to which enterprise systems have been integrated to enable delivery of the right information to the right person at the right time.	Process II: extent to which ES have been integration to deliver the necessary information throughout business process within organizations and across their supply chains. Hierarchical II: extent to which ES have been integrated to deliver necessary information to individuals at different levels of organizations.
Chapman and Kihn (2009)	IS Integration: NA	NA
Dong et al. (2009) RBV SCM	Back-end integration: links Web applications with back-office databases and facilitates information sharing along the value chain	NA
View of Integration as a Multi-Dimensional Construct		
Voss (1989) CIM	Integration: Encompass 5 dimensions.	Strategy: NA Material flow: NA

		Technical: NA Information: NA Organization: NA
Bullers and Reid (1990) CIM	Integration: NA	System: NA Horizontal: involves coordination among the manufacturing functions. Vertical: allows ISs to be accessed by throughout the organization. Temporal: allows consideration of the past, present, and future. Physical: promotes coordination among dispersed facilities.
Venkatraman and Zaheer (1990) EDI TCT	Electronic Integration: integration of business processes of two or more independent organizations through the exploitation of the capabilities of computers and communication technologies.	Business process: NA Computer and communication technologies: NA
Das (1992) Manufacturing CIM	Manufacturing integration: NA	Resource oriented: concerns a physical resource, i.e. computer & network, equipment, facilities, and material. Activities oriented: refer to facets of the different manufacturing activities. Process, information, decision tools, product, control integration.
O'Sullivan (1992) CIM	Integration: comprising social as well as technical elements.	Social: integration of peoples, their ideas, and the decision-making processes. Include Information, data, equipment Technical: integration of subsystems, which include equipment, techniques, and procedures. Management, system designer, users
Lim et al. (1997)	Enterprise Integration: task of improving the performance of complex organizations by managing the interactions among the participants. Take into account the communication, interaction issues between people, departments, organizations, services, IS, etc.	Systems integration: using computer communication networks and protocols. Application integration: shared data and data exchange format. Business process:
Kosankee et al. (1999)	Enterprise Integration: provide the right information at the right place and at the right time and thereby enable communications between people, machines, and computers and their efficient cooperation and coordination.	System: NA Application: NA Business: NA
Ramamurthy et al. (1999) EDI	EDI Integration	Internal Integration: integration of EDI systems with partners. External Integration: integration of EDI with internal systems.

Booth et al. (2000)	Enterprise Information Systems Integration: NA	Data integration: NA Enterprise communication networking: hardware and software integration and flexibility (technical). Information integration: scope of interchange and use of data and information generated by internal and external sources. Levels of ERP integration: FII: High-level software, data, and information integration. FSI: High-level software and data integration but low-level information integration PI: Low-level integration on any 2 of the 3 criteria. NI: Low-level integration on all 3 criteria.
Markus (2000) E-Business	Integration: NA	Business: creation of tighter coordination among the business activities conducted by different individuals, work groups, or organizations so that a unified business process is formed. Internal: within a single organization External: across organizations System: creation of tighter linkages between different IS and databases.
Waring and Wainwright (2000) IS	IS Integration: NA	Technical: NA System: NA Organizational: NA Strategic: NA
Chalmeta et al. (2001) Modeling	Enterprise Integration: enterprise's organization and functioning which includes activities, decisions, resources and information flow in a joint system in such a way that everything behaves in a coordinated manner in order to satisfy global objectives and improve performance.	Process: NA Information Systems: NA
Barnes et al. (2002) E-commerce	Integration: NA	Internal Business process: the extent to which processes for clicks and mortar e-commerce are integrated with those of brick and mortar. External Business process: extent to which the processes are outsourced IS: extent to which inter and intra-organizational IS are capable of sharing and communicating information with each other both internally and externally.
Beretta (2002) ERP	Integration: NA	Information: transferring information efficiently throughout the

		organization. Cognitive: professionals understand others Managerial: personal commitment of each manager
Ribbers and Schoo (2002) ERP Complexity	Integration: planned changes to be realized through the implementation program in terms of integration of IT systems and across business processes.	Process: NA Structural: NA Social: NA Technical: NA
Huang et al. (2003) ERP/SCM/ CRM	Corporate Applications Integration	Data: compatibility of data definitions and encoding formats between the systems to be integrated. Applications: at the program/code level. Business process: alignment of business workflow, success criteria, data definition, and standards.
Lee et al. (2003) ERP	Enterprise Integration (Systems): capability to integrate a variety of different system functionalities	Technical: software and hardware. Behavioral: redistribution of roles and responsibilities among members.
Beretta (2004) Process based performance measure	Organizational Integration: creation of a context that helps coordination of actions	Information: transferring information efficiently throughout the organization. Cognitive: each professional understand the point of view of the other professionals. Managerial: personal commitment of management.
Davenport et al. (2004) ERP	Integrate: unify and harmonize ES, data, and processes with an organization's unique environment, and use the systems to better connect organizational units and processes, as well as customers and suppliers	Business process: NA Data: NA External: NA Internal: NA
Giachetti (2004)	Information Integration: NA	Network level: linkages between systems, applications, and modules. Data: two or more subsystems or organizational units exchange data with each other. Application: ability of one software application to access/use data generated by another software system. Process: the systems are connected, data is shared in the organization, the applications can interoperate, and the business processes are coordinated with the IS and other processes.
Wainwright and	IS Integration: NA	Technical: data, communication,

Waring (2004) IS		automation. Systems: operations, workflow, business processes Strategic: internal and external Organizational: social and political
Barki and Pinsonneault (2005)	Organizational Integration: extent to which distinct and interdependent components constitute a unified whole.	Internal: integration within a firm Internal-operational: integration of successive stages within the primary process chain of a firm Internal-functional: integration of administrative or support activities of the process chain of a company External: integration of at least two independent firms. E-operational-Forward: integration of successive process chain stages into distribution and retail E-operation-Backward: integration of successive process chain stages into supply. E-Operational-lateral: integration of successive process chain stages into components or parts. External-Functional: integration across firms of administrative or support activities.
Gattiker and Goodhue (2005) ERP OIP	Integration: NA	Data Integration: NA Process Integration: NA Physical scope: NA
Grant and Tu (2005) ERP	Integration: Collection of related entities, such as CIS, MS, and people to form a unified whole.	Levels of ERP integration: System-specific Integration: specification and compatibility integration. System-User Integration: ensuring that users are integrated with the technology and the environment. (ergonomic and cognitive integration). Island of Technology Integration: ability of dispersed islands to communicate with each other. Organization integration: value-chain integration that manages the efforts of various functions across the value-chain. (Four types). Socio-Organizational Integration: integrated CRM, SCM, and the coordination of the task environment. (4 types). Global Integration: Issues of language, time difference, culture, etc. (3 types).
Rowe et al. (2005) ERP	Cross-functional overview: people awareness of the coupled	Cognitive: NA Business Process: NA

	and transverse nature of processes across different units. Cross-functional integration: extent to which different business processes and functions are interconnected, standardized, and tightly coupled.	
Volkoff et al. (2005) ERP and IP Theory	Organizational integration	Process: standardized processes, tightly coupled processes, continuously coordinated processes. Data: standardized data, high data accuracy and consistency, real-time data sharing.
El Amrani et al. (2006) ERP	Cross-functional overview: people awareness of the coupled and transverse nature of processes across different units. Cross-functional integration: extent to which different business processes and functions are interconnected, standardized, and tightly coupled.	Cognitive: NA Business Process: NA
Mendoza et al. (2006) EAI	Systems Integration: 4 levels	Point-to-point: basic infrastructure for exchanging information between applications Structural: companies use more advanced tools to standardize and control the information exchange between applications. Process: managing the information flow between applications. External: real-time business applications, transformation of processes, and new customer-focused structures.
Rai et al. (2006) SCM	Supply chain integration capability	IT infrastructure Integration: degree to which a firm has established IS for the consistent and high-velocity transfer of SC related information within and across its boundaries. Data consistency: Degree to which common data definitions and consistency in stored data have been established across a firm's SC Cross-functional SCM Application Systems Integration: Degree of real-time communication of a firm's function specific SCM applications with each other and related ERP and CRM applications. SC Process Integration: Degree to which a firm has integrated its financial, information, and physical flows with its SC. Physical flow integration: Degree to

		which a firm uses global optimization with its SC partners to manage the stocking and flow of materials and finished goods. Financial flow integration: Degree to which financial flow between a firm and its SC partners is driven by workflow events. Information flow integration: Extent of operational, tactical, and strategic information sharing that occurs between a firm and its SC partners.
Ranganathan and Brown (2006) ERP	Organizational Integration: extent to which distinct and interdependent components constitute a unified whole.	Technical: integrated and standardized IT infrastructure across internal organizational unit. Business: support cross-functional business processes.
Bharadwaj et al. (2007) Manufacturing	Integrated IS capability: degree to which the focal firm's information systems provide integrated data and process integration.	Data: access to relevant data Process: coordinate activities with SC partners
Devaraj eta l. (2007) Ebusiness (RBV, relational view, and theory of swift and even flow	Production Information integration: nature of the information that is shared between entities in a supply chain and supported by the collaborative efforts that result in improved production information accuracy.	Supplier Integration: inventory ordering policies, inventory levels, and master production schedules Customer Integration: sharing of real-time point-of-sales data, sales forecasts, customer profiling, and customer relationship management
Elbanna (2007) ERP Actor Network Theory (ANT)	Enterprise Integration: NA	Technical: operability and technical characters of software and hardware. Operational: streamlining and amalgamation of business activities and processes. Social: willingness and ability of different individuals, work groups, and organizations to work together in order to develop, establish, and carry out integrated processes, and to be part of the same integrated organization.
Oh et al. (2007) RBV	Organizational Integration: extent to which distinct and interdependent components constitute a unified whole.	Internal OI: integration of internal processes within a firm. External OI: integration of processes between firms and across boundaries of the firm.
Gustavsson (2008) Manufacturing	Process Integration: NA	Internal organizational: communication and meetings, shared decision-making. Internal technical: Interfaces supporting planning information exchange between two or more MPC processes within a company

		External organizational: Interfaces supporting planning information exchange between companies. External Technical: Interfaces and ICT compatibility
Angeles (2009) SCM	IT Infrastructure integration: degree to which a focal firm has established IT capabilities for the consistent and high-velocity transfer of supply chain-related information within and across its boundaries. Supply chain process integration the degree to which a hub firm has integrated the flow of information, physical materials, and financial information with its value chain trading partners. Information	Data consistency: the extent to which data has been commonly defined and stored in consistent form in databases linked by supply chain business processes. Cross-functional supply chain management applications systems: level of real-time communication of a hub firm's functional applications that are linked within an SCM context and their exchanges with ERP and other related interenterprise initiatives.
Berente et al. (2009)	Information Integration: linkage of syntactic aspects of communication associated with business processes	Process: extent to which the effort associated with information flows between activities is minimized. Data: common definitions of electronic data across functional groups. Application: electronic linking of autonomous applications. System: connections of disparate systems.
Kien and Lian (2009) ERP	Enterprise Integration: process of achieving unity of effort among the various subsystems in the accomplishment of the organization's tasks.	Business: creation of tighter coordination among the discrete business activities. System: creation of tighter linkages between different IS and databases. Strategic: drives business and system integration as well as communicates and links top management's definition of one enterprise to the rest of the organization.
Raymond et al. (2009) SME Manufacturing	Business Process Integration: Integration of business processes across functions and organizations	Technical: standardization of the technology and data access. Process: standardization of business processes within a firm and/or with its business partners.

Appendix B: Studies Providing Measures of Integration

Concept	Authors	Operationalization
Electronic Integration (EDI)	Venkatraman and Zaheer (1990)	Electronic integration or not.
	Bergeron and Raymond (1992)	Numbering the different types of EDI applications and trading partners.
	Premkumar et al. (1994)	Internal: Aggregate measure of 5 majors IS applications. External: Extent of total external partners and total documents that are linked to EDI.
	Zaheer and Venkatraman (1994)	% of business directed to the interfaced carrier through the proprietary electronic channel.
	Srinivisan et al. (1994)	Integrated or not with EDI (1 or 0)
	Iacovou et al. (1995)	Numbering the different types of EDI applications and trading partners.
	Massetti and Zmud (1996)	Functional 1. Number of document types exchanged via EDI 2. Specific standards used Organizational 1. Number of functions using EDI 2. Number of document types exchanged via EDI
	Hart and Saunders (1997)	Volume and diversity of EDI use
	Williams et al. (1998)	Range: % of trading partners linked via EDI. Width: Whether or not some documents are transmitted/received via EDI with trading partners. Depth: % of data processing done via EDI (proportion of documents).
	Ramamurthy et al. (1999)	External Integration: Number of transaction sets implemented via EDI expressed as a proportion of the 18 possible transaction set types weighted by the proportion of business transactions of each of this type conducted via EDI mode. Internal Integration: Extent of integration of EDI information with: 1. Delivery tracking system. 2. Billing system. 3. Accounts Receivable.
	Truman (2000)	Internal Within and between sub-units (3 for each) % scale or ratio of the ideal and actual amount of integrated data elements as a % of all data elements. 100- |Ideal-Actual| Interface 1. For each transaction types (5), the extent to which the data are merged with systems' data in terms of manual versus automated procedures. 2. Broad characterization of interface integration.

		Technology cluster: AVG of 2nd item across all 5 transaction types.
	Christiaanse and Venkatraman (2002)	Percentage of the independent travel agency's business directed to the focal airline whose information system is primary in the agency business operations.
	Mukhopadhyay and Kekre (2002)	EDI versus Manual
	Lee and Lim (2003)	Integration with 5 IS selected by respondents for five tasks.
	Kurokawa et al. (2008)	"1" for respondents who developed EDI communication with their average suppliers by using one of the five EDI transactions, and "5" for respondents who developed EDI communication with their average suppliers by using all of the five EDI transactions—i.e., (1) *application advice*, (2) *planning schedules*, (3) *advance shipping notices*, (4) *receiving advice*, and (5) *shipping schedules*.
System integration	Goodhue et al. (1992)	Data Integration 1. Number of fields with common definition and codes. 2. Number of systems or databases that adhere to these standards.
	Gustin et al. (1995)	Which represent the current level of implementation of integrated logistics within their firms. 4 scenarios, 1-3 are nonintegrated, 4 is integrated.
	Swan et al. (1999)	Extent to which the various systems in use had been integrated.
	Booth et al. (2000)	Paired combinations of functional areas for the level of integration achieved. Data Integration 1. One common database for all applications, integrity, common formats, primary keys, etc. Enterprise Communication networking 1. Common source codes, common protocols, seamless interfaces, etc. Information integration 1. Interchange and use of data and information generated by functional areas/applications in the enterprise.
	Zhu and Kraemer (2002)	Supplier Integration 1. Online procurement: Internet-enabled procurement of raw materials, supplies and parts by the manufacturer. 2. EDI links: Whether the company uses EDI or extranet for SC management. 3. Supplier Virtual Community: Whether the company offers an online community dedicated to suppliers. 4. Integration to backend IS: An indication of online integration with databases and backend IS with suppliers. 5. Fulfillment and logistics: A functionality to facilitate shipment and logistics management with suppliers and distributors via the Internet. 6. Inventory data sharing: whether inventory information is updated and shared online with suppliers

		and business partners through electronic links.
	Barua et al. (2004)	1. Data can be shared easily among various internal systems. 2. Our systems can easily transmit, integrate, and process data from suppliers/vendors and customers. 3. Order changes are automatically reflected in downstream processes or systems. 4. Our systems allow continuous monitoring of order status at various stages in the process. 5. Employees can easily retrieve information from various databases for decision support.
	Zhu (2004)	Back-end Integration 1. Integrate the web-based front system with corporate databases and back-end IS. 2. Do the back-office systems share common standards of data and communication. 3. The extent to which the back-end systems are compatible with each other and with the Internet protocol. 4. Whether the firm uses EDI or Extranet to transfer invoice data with its suppliers and business partners. 5. Allows suppliers to check inventory in stores and warehouses through electronic links and facilitate auto replenishment. 6. A functionality to facilitate shipment and logistic management with suppliers and distributors via the Internet. 7. Whether customers can log on to the Web site to view the status of the order processing and shipment.
	Bhatt and Troutt (2005)	Data Integration 1. The same information is recorded in more than one file. 2. The same information is stored in separate systems for different application areas. 3. Inconsistencies occur because separate copies of data are updated at different times. 4. Data storage requirements could be reduced by eliminating duplicate data in separate applications. 5. Definition of key data elements are standardized. 6. All function areas use the same logical coding scheme to represent information. 7. All function areas use the same document format standard in sharing technical documents. Communication networks connectivity 1. Operating personnel can access authorized data through CM. 2. Operating personnel can exchange their ideas and document through CM. 3. Departments can share data and applications on the CM. 4. Senior management can access business specific information from their workstations. 5. Through CM, management can distribute the latest business information within the firm. 6. The firm and its main customers are linked by CM.

		7. The firm and its main suppliers are linked by CM. 8. The firm and field staff/sales persons are linked by CM. 9. Corporate headquarters and the firm are linked by CM. 10. Through communication networks, senior management can distribute latest information to the firm's suppliers. Communication networks flexibility 1. Future requirements of the firm's CM "connectivity" have been planned in advance. 2. CM have been designed to adapt to a firm's future applications. 3. CN standards have been employed for designing future ISs. 4. A consistent set of procedures and policies are used for managing CM. 5. Corporate data can be seamlessly accessed from remote locations. 6. IS network architecture can be modified without disrupting information sharing within the firm.
	Zhu and Kraemer (2005)	Back-end integration 1. Web applications are electronically integrated with back-office systems and databases. 2. Company databases electronically integrated with suppliers and partners.
	Saeed et al. (2005)	External Classification of existing electronic linkages into 4 progressive stages. Stage 1 and 2 are Level 1 and stage 3 and 4 are Level 2 of external integration. Internal 1. We encourage sharing of databases across functional areas of the firm. 2. We have extensive networking facilities within our firms. IOS Breadth 1. Number of suppliers with whom the firm has electronic linkages. 2. Total number of suppliers with whom the firm routinely interact. IOS initiation 1. Number of electronic links initiated by the firm 2. Total number of electronic links the firm has established.
	Langdon (2006)	1. We have integrated most of our software applications 2. Most of our software applications work seamlessly. 3. Software applications on multiple machines of multiple vendors are interoperable with each other. 4. Our software applications and DBMS function as an integrated IS. 5. We have successfully integrated our most of our software applications and databases. 6. We have successfully blended our IT components into a functional whole or a unified IS.

	Mendoza et al. (2006)	Point-to-point integration 1. Documentation of existing errors between the communication interface and the documented applications. 2. Rate of requests that have been interchanged successfully in a certain time. 3. Fulfillment of test plans for the communication interface.
	Zhu and Kraemer (2006)	1. Extent to which Internet systems are connected with back-office IS and databases. 2. Extent to which company databases are linked to business partners' systems and databases.
	Ward and Zhou (2006)	Whether some IT systems/processes (ERP, MRP, etc.) are implemented or not.
	Rai et al. (2006)	IT Infrastructure integration for SCM <u>Data consistency:</u> 1. Automatic data capture systems are used across the SC. 2. Definitions of key data elements are common across the SC. 3. Same data stored in different databases across the SC are consistent. <u>CFAI:</u> The following application communicate in real time 1. SC planning applications. 2. SC transaction applications. 3. SC applications with internal applications of our organization. 4. Customer relationship applications with internal applications of our organization.
	Bharadwaj et al. 2007	Data Integration Our production/ERP allows us integrated access to data to a) all customer-related data, b) all order-related data, c) all production-related data, d) all market-related data.
	Grover et al. (2007)	IOS integration 1. The extent to which our company shares databases with supplier S. 2. The extent to which our company shares applications with supplier S. 3. The extent to which our company exchanges files with supplier S.
	Chapman and Kihn (2008)	IS integration 1. Information in reports produced by our information systems is entirely based on common sources of data (e.g. a common database). 2. We have fully-integrated information systems that contain both financial and non-financial information.
	Dong et al. (2009)	Backend integration 1. Extent Web applications are electronically integrated with back-office IS and databases. 2. Extent company databases are electronically integrated with those own by upstream suppliers and downstream partners. 3. Extent the firm has used the Internet to support

		information sharing along the supply chain. (aggregated index of a list of 3 activities).
Organizational Integration	Brandyberry et al. (1999)	1. The production subsystems used by my organization are highly integrated with each other. 2. The production systems used by my organization are highly integrated with other functional systems. 3. Information generated by the production system in my organization is easily and quickly retrieved by those who need it. 4. My organization maintains a consistent and accurate database of production information.
	Oh et al. (2007)	Internal 1. The business processes of our operational departments are well integrated with one another. 2. Our operational departments have business processes which are standardized for information exchange. 3. Information is shared effectively across our operational departments. 4. The business processes of our support departments are well integrated with one another. 5. Our support departments have business processes which are standardized for information exchange. 6. Information is shared effectively across our support departments. 7. Overall, the integration between our operational and support departments is high. External 1. The business process of our operational departments are well integrated with those of our partner organizations. 2. Our operational departments are well interconnected with those of our partner organizations. 3. Information is shared effectively across the operational departments of our organization and our partner organizations. 4. The business processes of our support departments are well integrated with those of our partner organizations. 5. Our support departments are well interconnected with those of our partner organization. 6. Information is shared effectively across the support departments of our organization and our partner organizations. 7. Overall, the integration between the operational and support departments of our organization and those of our partner organizations is high.
Business Process integration	Berente et al. (2009)	Unnecessary time expended in dealing with information inputs and outputs for the business processes (for each dimension: timeliness, granularity, accessibility, transparency).

	Rai et al. (2006)	SC Process Integration Financial: 1. Account receivables processes are automatically triggered when we ship to our customers. 2. Account payables processes are automatically triggered when we receive supplies from our suppliers. Physical: 1. Inventory holding are minimized across the supply chain. 2. SC-wide inventory is jointly managed with suppliers and logistics partners. 3. Suppliers and logistics partners are deliver products and materials just in time. 4. Distribution networks are configured to minimize total SC-wide inventory costs Information: 1. Production and delivery schedules are shared across the SC. 2. Performance metrics are shared across the SC. 3. SC members collaborate in arriving at demand forecast. 4. Our downstream partners share their actual sales data with us. 5. Inventory data are visible at all steps across the SC.
	Bharadwaj et al. (2007)	To what extent does your ERP facilitates the following coordinated activities with your suppliers (a and b) and buyers (c and d) a) Knowledge of the maintenance of inventory mix/levels. b) Delivery scheduling and tracking. c) Knowledge of the maintenance of inventory mix/levels. d) Delivery scheduling and tracking.
	Devaraj et al. (2007)	Production Information Integration Supplier Integration 1. My company provides the following information items to the supplier: Sales forecast, Master production schedule, The inventory status. 2. My company collaborates with the supplier to jointly develop the net requirements of the component that the supplier will need to deliver. 3. My company authorizes the supplier to automatically replenish the inventory of the component. Customer Integration 1. The customer provides the following information about its final product to my company: Sales forecast, Master production schedule, The inventory status. 2. The customer collaborates with my company to jointly develop the net requirements of the product that my company supplies (0.714). 3. The customer authorizes my company to automatically replenish the inventory of the product my company supplies.
	Paulraj and	External logistic integration

	Chen (2007)	1. Inter-organizational logistics activities are closely coordinated. 2. Our logistics activities are well integrated with the logistics activities of our suppliers. 3. We have a seamless integration of logistics activities with our key suppliers. 4. Our logistic integration is characterized by excellent distribution, transportation and/or warehousing facilities. 5. The inbound and outbound distribution of goods with our suppliers is well integrated. 6. Information and materials flow smoothly between our supplier firms and us.
	Chang et al. (2009)	Information Integration: only 1 item provided Process II: IS in our firm are linked in such a manner that information captured in one part of a business process is available to other parts of the process. Hierarchical II: IS in our firm are linked in such a manner that information is available for tope executives to form corporate strategies and policies.
	Raymond et al. (2009)	Extent to which manufacturing applications (6) implemented are actually assimilated by the organization (scale of 1-5; total from 0 to 30)
User Integration	Rowe et al. (2005) El Amrani et al. (2006)	1. ERP users have a broader perspective of their department. 2. ERP users have a broader perspective of their company. 3. ERP users are more aware of the transverse character of cross-functional processes. 4. ERP users are more aware of the effect their actions may have of the work of others. 5. ERP users believe that they have a single system of reference.
ERP Integration	Hitt et al. (2002)	Functional # of modules implemented, Level 0, 1, 2A, 2B, and 3.
	Ribbers and Schoo (2002)	Reach: within location to all over the world. Range: from single, local support to cooperative transactions.
	Barki et al. (2005)	Breadth: single site versus multiple sites
	Gattiker and Goodhue (2005)	Physical: # sites
	Cotteleer and Bendoly (2006)	Physical: # sites
	Rowe et al. (2005) El Amrani et al. (2006)	Functional: # of modules implemented
	Ragananthan and Brown (2006)	Functional: # of modules implemented (full suites or 2 or more value-chain module VS one value-chain module or 1+ support modules). Physical: multilocation VS single site.
	Karimi et al. (2007)	Functional: # of modules implemented Organizational: scope of implementation

		(department/division/entire company/multiple companies/other) Geographic: #sites: geographical extent of implementation (Single site/multiple sites/national/worldwide)

Appendix C: Card Sorting Results

Results Round #1

Items	Data	App.	BP	Cog.	Beh.	Others **	Avg Agree
Data Integration							
The module provides high level of enterprise-wide data integration.	9			1			0.90
The module allows us integrated access to data to all customer-related data.	6	3	1				0.60
Same data stored in different databases across the module are consistent.	10						1.00
The module allows us integrated access to data to all order-related data.	7		2			1	0.70
The module allows us integrated access to data to all production-related data.	7	1	1			1	0.70
The module allows us integrated access to data to all market-related data.	7	2	1				0.70
Data can be shared easily among various modules.	9	1					0.90
Definitions of key data elements are common across the modules.	9			1			0.90
SI Applications							
The module is integrated with other modules.		10					1.00
The module is integrated with other IS systems and databases.		9	1				0.90
The module and databases function as an integrated system.	1	9					0.90
Information generated by the module is easily and quickly retrieved by those who need it.		5	4			1	0.50
The module communicates in real time with other modules.		9	1				0.90
BPI							
The business processes are well integrated with one another.			9			1	0.90
The module facilitates the coordination of activities across our department.			6			4	0.60
The module facilitates the coordination of activities within our department.		1	4			5	0.40
The information is shared more effectively across our departments using the module.			2			8	0.20

There are more types of information exchanged across our department using the module.		1	3			6	0.30
There is greater volume of information that is shared across our department using the module.		1	3			6	0.30
We have a seamless integration of our activities with our key departments.		1	6		2	1	0.60
Our business processes are standardized for information exchange with other departments.	1	1	8				0.80
UI cognitive*							
The users of the module are aware of the integrative nature of the module in their department.			1	8	1		0.80
The users of the module are aware of the integrative nature of the of cross-functional business processes.				9	1		0.90
The users of the module are aware of the integrative nature of the other module in their company.				10			1.00
UI Behavorial*							
The users of the module understand how their work activities impact the work of other ERP users.				2	8		0.80
The users of this module understand how their work activities support the goals of the other module.				2	8		0.80
The users of the module understand how their work activities impact the operations of business processes of other functional areas.					10		1.00
Total Card per construct (category)	64	42	41	27	26	34	234
Average Agreement	0.80	0.84	0.51	0.90	0.87	NA	
# of Participants	10						
# of items/construct	8	5	8	3	3	NA	

Items in bold were deleted and items in italic were modified.
* New items were generated for this construct.
** Other constructs were tested at the same time of this card sorting.

Round #2

Items	Data	App.	BP	Cog.	Beh.	Avg Agree
Data Integration						
The module provides high level of enterprise-wide data integration.	9	1				0.90
The module allows us integrated access to all data.	8	2				0.80
Same data stored in different databases across the module are consistent.	10					1.00
Data can be shared easily among various modules.	10					1.00
Definitions of key data elements are common across the modules.	10					1.00
SI Applications						
The module is integrated with other modules.		10				1.00
The module is integrated with other IS systems and databases.*	3	6	1			0.60
The module and databases function as an integrated system.	2	7	1			0.70
The module communicates in real time with other modules.		9	1			0.90
BPI						
The business processes are well integrated with one another.			10			1.00
The activities of our business processes are closely coordinated.			8	1	1	0.80
We have a seamless integration of our activities within our department.			8	1	1	0.80
We have a seamless integration of our activities with our key departments.		1	7	1	1	0.70
Our business processes are standardized for information exchange with other departments.			9		1	0.90
UI cognitive						
The users of the module are aware of the integrative nature of the module in their department.				10		1.00
The users of the module are aware that the different modules and business processes are tightly coupled.		1		9		0.90
The users of the module are aware of the integrative nature of the cross-functional business processes.				9	1	0.90
The users of the module are aware of the integrative nature of the other module in their company.				10		1.00
UI Behavorial						
The users of the module understand how their work activities (entering new data, modifying data, deleting data, etc.) impact the work of other ERP users.					10	1.00

The users of the module understand how their work activities impact the business processes of the department.					10	1.00
The users of the module understand how their work activities support the goals of the other modules.				1	9	0.90
The users of the module understand how their work activities impact the operations of business processes of other functional areas.					10	1.00
Total Card per construct (category)	47	32	42	38	39	198
# of different cards per construct (category)	5	5	3	4	5	22
Total Hits	44	27	39	35	34	169
Ratio of Total Hits/Total card	0.94	0.84	0.93	0.92	0.87	0.85
Average Agreement (category)	0.94	0.80	0.84	0.95	0.98	
# of items/construct	5	4	5	4	4	

* This item was kept since it shown a satisfactory agreement in the previous round.
Items in italic were modified.

Appendix D: Questionnaire Items

Constructs	Items	Reliabilities and descriptive data
System Integration 5-point-scale (0-5) (Strongly agree – Strongly disagree)	SI 1: The ERP module is integrated with the various IT applications in your unit. (NEW) SI 2: The module with other IT applications has been combined into a functional whole or a unified system. (NEW)	Mean = 2.47 Std. dev. = 1.04 α = 0.85
Data Integration *Source:* Barua et al. 2004, Rai et al. (2006) 5-point-scale (0-5) (Strongly agree – Strongly disagree)	DI 1: Data can be shared easily among various ERP modules. DI 2: Definitions of key data elements are common across the modules. DI 3: The same data stored in different databases across the ERP module are consistent.	Mean = 2.01 Std. dev. = 0.973 α = 0.84
Application Integration *Source*: Langdon (2006), Rai et al. (2006) 5-point-scale (0-5) (Strongly agree – Strongly disagree)	AI 1: The module is integrated with other modules. AI 2: The module and databases function as an integrated system. AI 3: The module communicates in real time with other modules.	Mean = 1.97 Std. dev. = 0.893 α = 0.75
Business process integration *Source:* Bhardwaj et al. (2007), Oh et al. (2007), Paulraj and Chen (2007). 5-point-scale (0-5) (Strongly agree – Strongly disagree)	BP1: The business processes are well integrated with one another. BP2: The activities of our business processes are integrated within our department. BP3: The activities of our business processes are closely coordinated. BP4: The activities of our business processes are integrated with the business processes of other departments. BP5: Our business processes are standardized for information exchange with other departments. (NEW)	Mean = 2.35 Std. dev. = 0.85 α = 0.91
Cognitive integration 5-point-scale (0-5) (Strongly agree – Strongly disagree)	CI2: The users of the ERP module are aware of the integrative nature of the other module (s) in their company. (NEW) CI3: The users of the ERP module are aware of the integrative nature of the of cross-functional business processes. (NEW) CI4: The users of the ERP module are aware that the different modules and business processes are tightly coupled. (NEW)	Mean = 2.33 Std. dev. = 0.95 α = 0.94
Behavorial Integration 5-point-scale (0-5) (Strongly agree – Strongly disagree)	BI 1: The users of the module understand how their work activities (entering new data, modifying data, deleting data, etc.) impact the work of other ERP users. (NEW) BI 2: The users of the module understand how their work activities (entering new data, modifying	Mean = 2.53 Std. dev. = 0.98 α = 0.93

	data, deleting data, etc.) support the goals of the other modules. (NEW) BI 3: The users of the module understand how their work activities (entering new data, modifying data, deleting data, etc.) impact the operations of business processes of other. (NEW)	
User Integration 5-point-scale (0-5) (Strongly agree – Strongly disagree)	UI1: The users of the module have similar understandings of its functioning and integrative nature. (NEW) UI2: The users of the module understand the impact that their usage can have on the work of other users of the module. (NEW)	Mean = 2.52 Std. dev. = 0.97 $\alpha = 0.90$
ERP Module Integration 5-point-scale (0-5) (Strongly agree – Strongly disagree)	MI1: The ERP module, its users and business processes are well integrated. (NEW) MI2: This ERP module is well integrated with other relevant IT applications and business processes. (NEW)	Mean = 2.49 Std. dev. = 1.02 $\alpha = 0.78$
Business Process Performance 5-point-scale (0-5) (Strongly agree – Strongly disagree)	BPP1: The overall business process performance is high. (NEW) BPP2: The operation of our business processes is high. (NEW)	Mean = 2.47 Std. dev. = 0.98 $\alpha = 0.98$

Appendix E: Correlation Matrices and measurement statistics

System integration (model 1)

	CR	AVE	1	2	3
1. Data Integration	0.79	0.56	***0.75***		
2. Application Integration	0.79	0.56	0.71	***0.75***	
3. System Integration	0.85	0.74	0.82	0.83	***0.86***

The diagonal elements in ***italic bold*** are the square roots of the AVE.
The off-diagonal elements are the correlations between constructs.

	1	2	3	4	5	6	7
1. System Integration	1.00						
2. DI 1	0.70	1.00					
3. DI 2	0.61	0.64	1.00				
4. DI 3	0.50	0.53	0.75	1.00			
5. AI 1	0.71	0.37	0.52	0.43	1.00		
6. AI 2	0.44	0.57	0.18	0.27	0.46	1.00	
7. AI 3	0.67	0.62	0.49	0.61	0.70	0.43	1.00

System integration and performance (model 2)

	CR	AVE	1	2	3	4
1. Data Integration	0.79	0.56	***0.75***			
2. Application Integration	0.78	0.56	0.72	***0.75***		
3. System Integration	0.84	0.72	0.84	0.85	***0.85***	
4. Business process performance	0.98	0.96	0.51	0.52	0.61	***0.98***

	1	2	3	4	5	6	7	8
1. System Integration	1.00							
2. DI 1	0.72	1.00						
3. DI 2	0.62	0.63	1.00					
4. DI 3	0.53	0.54	0.76	1.00				
5. AI 1	0.74	0.35	0.52	0.45	1.00			
6. AI 2	0.44	0.57	0.31	0.26	0.44	1.00		
7. AI 3	0.70	0.61	0.49	0.60	0.71	0.42	1.00	
8. Business process performance	0.51	0.43	0.38	0.32	0.45	0.26	0.42	1.00

Business process integration (model 3)

	1	2	3	4	5	6
1. Business Process integration	1.00					
2. BPI 1	0.74	1.00				
3. BPI 2	0.82	0.61	1.00			
4. BPI 3	0.77	0.57	0.63	1.00		
5. BPI 4	0.88	0.65	0.73	0.68	1.00	
6. BPI 5	0.85	0.63	0.70	0.65	0.75	1.00

Business process integration and performance (model 4)

	CR	AVE	1	2
1. Business Process Integration	0.90	0.65	***0.81***	
2. Business Process Performance	0.98	0.96	0.77	***0.91***

	1	2	3	4	5	6	7
1. Business Process integration	1.00						
2. BPI 1	0.75	1.00					
3. BPI 2	0.86	0.64	1.00				
4. BPI 3	0.78	0.58	0.67	1.00			
5. BPI 4	0.83	0.62	0.71	0.65	1.00		
6. BPI 5	0.82	0.61	0.70	0.64	0.78	1.00	
7. Business process performance	0.77	0.57	0.66	0.60	0.64	0.63	1.00

User integration (model 5)

	CR	AVE	1	2	3
1. Cognitive Integration	0.94	0.83	**0.91**		
2. Behavorial Integration	0.93	0.81	0.67	**0.90**	
3. User Integration	0.90	0.82	0.75	0.89	**0.90**

	1	2	3	4	5	6	7
1. User integration	1.00						
2. CI 1	0.69	1.00					
3. CI 2	0.69	0.84	1.00				
4. CI 3	0.68	0.83	0.83	1.00			
5. BI 1	0.82	0.54	0.54	0.53	1.00		
6. BI 2	0.88	0.58	0.58	0.57	0.82	1.00	
7. BI 3	0.85	0.55	0.55	0.55	0.78	0.84	1.00

User integration and performance (model 6)

	CR	AVE	1	2	3	4
1. Cognitive Integration	0.94	0.83	**0.91**			
2. Behavorial Integration	0.93	0.81	0.67	**0.90**		
3. User Integration	0.90	0.82	0.75	0.89	**0.90**	
4. Business process integration	0.98	0.96	0.34	0.43	0.45	**0.98**

	1	2	3	4	5	6	7	8
1. User integration	1.00							
2. CI 1	0.69	1.00						
3. CI 2	0.69	0.84	1.00					
4. CI 3	0.68	0.83	0.83	1.00				
5. BI 1	0.82	0.54	0.54	0.53	1.00			
6. BI 2	0.88	0.58	0.58	0.57	0.82	1.00		
7. BI 3	0.84	0.55	0.55	0.55	0.78	0.84	1.00	
8. Business process performance	0.45	0.31	0.31	0.31	0.37	0.40	0.38	1.00

Overall reflective model (model 7)

	CR	AVE	1	2	3	4	5
1. System Integration	0.85	0.74	**0.86**				
2. Business process Integration	0.77	0.64	0.63	**0.80**			
3. User Integration	0.90	0.82	0.23	0.48	**0.90**		
4. ERP module Integration	0.82	0.56	0.73	0.90	0.62	**0.75**	
4. Business process Performance	0.98	0.96	0.59	0.69	0.47	0.76	**0.98**

	1	2	3	4	5	6	7	8	9	10
1. SI 1	1.00									
2. SI 2	.743	1.00								
3. BPI 1	.399	.406	1.00							
4. BPI 2	.456	.465	.627	1.00						
5. UI 1	.191	.195	.346	.395	1.00					
6. UI 2	.168	.171	.303	.346	.817	1.00				
7. MI 1	.531	.541	.537	.614	.486	.423	1.00			
8. MI 2	.449	.458	.455	.520	.409	.358	.550	1.00		
9. BPP1	.494	.504	.500	.572	.449	.394	.605	.512	1.00	
10. BPP2	.489	.498	.495	.565	.445	.390	.598	.507	.961	1.00

	System Integration	**Business Process Integration**	**User Integration**	**ERP Module Integration**	**Business Process Performance**
SI1	**.873**	.201	.011	.172	.180
SI2	**.865**	.160	.114	.174	.219
BPI1	.302	**.859**	.115	.170	.223
BPI2	.141	**.610**	.244	.269	.513
UI1	.017	.107	**.902**	.237	.165
UI2	.115	.116	**.924**	.024	.202
ERPMI1	.458	.144	.388	**.579**	.275
ERPMI2	.215	.217	.121	**.887**	.201
BPP1	.238	.199	.228	.185	**.888**
BPP2	.244	.229	.200	.169	**.888**

Chapter IV (Essay #3): Antecedents of ERP Module Integration and its Impact on Business Process Performance: An Empirical Analysis

Abstract: *A model of the impacts and antecedents of Enterprise Resource Planning (ERP) integration is presented. The model focuses at the module level of integration and includes business process outcomes through which impact occurs. Data collected from 148 ERP modules in different organizations are tested using EQS. The results suggest that ERP module integration depends on the degree of perceived gap and the integration process, which is composed of the identification, through search and alertness, and the exploitation, through design, of integrative opportunities. More specifically, design positively influences the degree of ERP module integration while perceived gap negatively influences it. Further, search is directly linked to design, while the link between alertness and design is mediated by search. The role of perceived gap is mitigated: it influences design, but not search. Finally, it is established that the higher the degree of ERP module integration, the higher the performance of the business processes.*

Introduction

Most CEOs rate business and technology integration of great importance and "extensive integrators" companies reported revenue increases three times as often as companies that were less integrated (IBM Survey 2007). Indeed, the "integrated enterprise" and the integration of IS are high on the agenda of many organisations (Wainwrigth and Waring 2004). Integration can speed up communications, improve decision-making, and link firms more easily with customers and suppliers (Davenport et al. 2004). Indeed, the meaning of integration has become associated with goals of greater efficiency, effectiveness, and competitiveness in organizations (Wainwrigth and Waring 2004). In contrast,

firms can suffer from lack of integration because they may be unable to obtain needed reports or respond quickly to customers' demands (Markus 2001).

Enterprise resource planning systems (ERPs) are software packages that can facilitate such integration. They enable a firm to integrate the complete range of the business's processes, IT applications, and data of an organization and are extended backwards to the fully integrated supply chain and forwards with Customer Relationship Management (CRM) systems (Markus and Tanis 2000; Wainwright and Waring 2004). Organizations vary in their ability to integrate these systems to realize their business benefits, suggesting that different degrees of integration can be achieved. Indeed, it has been shown that the higher the degree of ERP integration, the better a firm performs (Karimi et al. 2007; Ragananthan and Brown 2006; Volkoff et al. 2005). Therefore, it is clear that integration has an important role to play in firm performance.

However, empirical investigations about the degree of integration, its antecedents, and consequences are limited. We do not know much about the impact of different degrees of integration on performance and how they can be achieved. Building on the first two essays, this study extends previous research on ERP integration and examines the drivers of ERP module integration and its effect on business process performance. Understanding the intermediate benefits, as opposed to firm level benefits, should provide explanations to why certain overall impacts do or do not occur and how ERP module integration has the greatest effect on business process performance. Furthermore, this essay looks at antecedents to ERP module integration. More specifically, the role of search and alertness in identifying integrative opportunities, design in exploiting opportunities, and perceived gap, which should influence the degree of integration achieved and the level of search and design needed. This paper is therefore an effort to shed light on the performance differences across firms investing in similar ERP and is likely to bring a better understanding of the broad issue of the business value of ERP through integration, which is important from both an academic and practical perspective.

The rest of the paper is organized as follows. In the next section, the literature on the link between ERP and performance is presented. Then, a model is developed to better understand the role of integration on business process performance and its antecedents. The model is then tested using a unique data set of ERP module implementation. Based on structural equation modeling, the data are analyzed and results that present the antecedents and consequences to ERP module integration are revealed. Finally, a discussion, which includes the implications of the results and suggestions for further research, is presented.

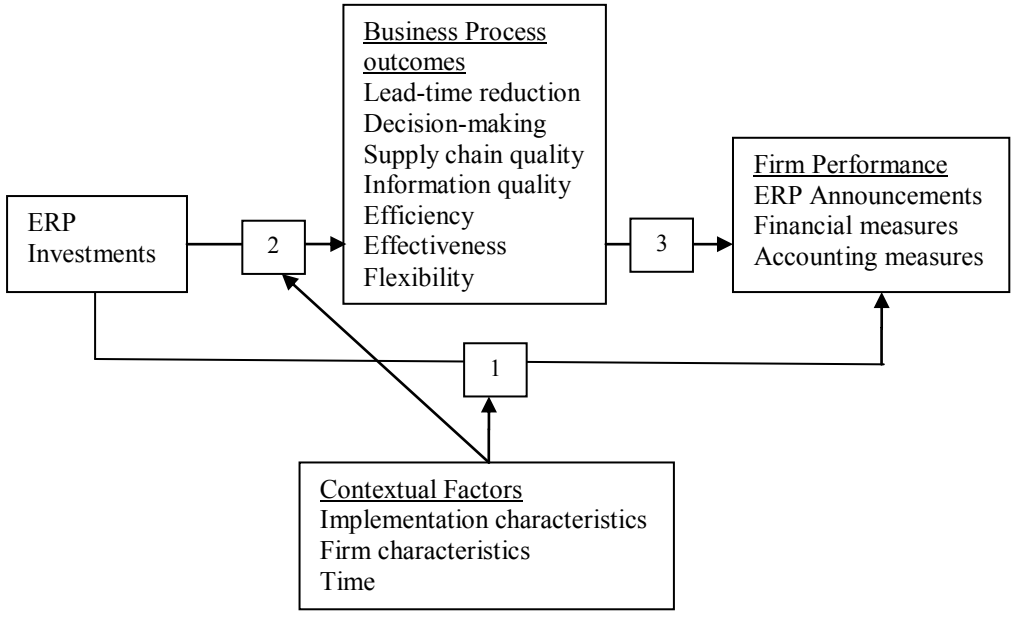
Literature Review: The Impact of ERP on Performance

Prior empirical research examining the performance impact of ERP has taken several forms (see Appendix A). Building on previous work (Dehning and Richardson 2002), a framework has been put forward to synthesize this research and provide evidence of the importance of integration in explaining the impact of ERP implementation. As shown in Figure 1, the relation between ERP and firm performance follows three paths, which are described next.

Path 1 is a direct link between ERP and overall firm performance. Most of the research is contained in this category where firm performance is measured using market measures (market valuation and Tobin's q), accounting measures (ROI, ROA, ROS, etc.), and objective data on stock returns (ERP announcements). From market and accounting perspectives, mixed results were found. For instance, no significant improvement in residual income over a 3 year period after implementation was found (Poston and Grabski 2001), while ERP adopting firms tended to perform better in terms of a wide variety of financial metrics such as sales per employee, profit margins, decrease in the ration of cost of goods sold to revenues, and market valuation (Hitt et al. 2002; Nicolaou et al. 2003; Poston and Grabski 2001). Similarly, no significant performance differences were found between ERP adopters and non-adopters (Wieder et al. 2006; Hunton et al. 2003). However, some found that the financial performance of adopters had not declined during the test period, whilst the performance of non-adopters had declined during the same period, suggesting that financial gains

arising from ERP adoption may be passed on to customers in the form of lower prices; hence, the performance of nonadopters declines by comparison (Hunton et al 2003). With respect to pre-to post-ERP adoption gains, studies found limited evidence of efficiency gains (Hunton et al. 2003; Poston and Grabski 2001). Finally, the other set of studies, which examines the financial performance of ERP implementation in terms of market reactions, found statistically significant abnormal stock market returns, indicating that the market reacts positively to ERP investment announcements (Hayes et al. 2001; Ho et al. 2008; Hunton et al. 2003; Ranganathan and Brown 2006). Market reaction articles argue that the implementation cost associated with ERP should result in long-term benefits, such as improved productivity and profitability, which can have a permanent effect on future cash flows (Hayes et al. 2001). Only one study found mixed results, i.e. ERP improve profitability but not stock returns (Hendricks et al. 2007).

Figure 1. Synthesis of the literature on ERP –Performance



At the process level (path 2), evidence of a causal link between ERP and subsequent improvement in operational performance measures (efficiency, flexibility, and effectiveness), information quality, lead-time reduction, decision

making, and quality level in supply chain were found (Cotteleer 2006; Cotteleer and Bendoly 2006; Laframboise and Reyes 2005; McAfee 2002; Spathis and Ananiadis 2005). However, no significant performance differences between ERP adopters and non-adopters were found at the supply chain level (Wieder et al. 2003) and mixed results were found for information quality and supply chain effectiveness (Akkermans et al. 2003; Booth et al. 2000).

Finally, some studies have looked at both the link between ERP and business process performance (path 2), and its impact on firm performance (path 3). Again, mixed results were found. More specifically, for some research, it was found that ERP led to operational efficiencies, which improved overall benefits (Chou and Chang 2008; Gattiker and Goodhue 2005; Matolcsy et al. 2005), while improvement of operational performance due to ERP systems did not materialize at the firm level (Vemuri and Palvia 2006; Wider et al. 2006).

Contextual factors have been introduced in hopes of better explaining the link between ERP and performance and some of the mixed results found in the previous section. These factors have been divided into three categories, namely (1) implementation characteristics, (2) firm characteristics, and (3) time. At the firm level (path 1), time, implementation characteristics such *implementation scope*, *vendor type*, *implementation goals*, and firm characteristics such as *size* and *financial health* have been found to influence the final results. For instance, some research considered and investigated the time-factor in more detail, or more precisely, the difference between the implementation of an ERP and when performance is measured. The results of these studies suggest the existence of a time-lag of approximately two years between the implementation of an ERP and the realisation of benefits (Ho et al. 2008; Hunton et al. 2003; Matolcsy et al. 2005; Nicolaou 2004; Poston and Grabski 2001). Recent research has shown that the stock market partially anticipates many corporate announcements and in other cases abnormal stock price performance is also observed subsequent to the announcement. This suggests that to get a better idea of the value of ERP investments, one should estimate abnormal performance over a longer time period (Hendricks et al. 2007). Indeed, it was found that significant positive

revisions occur in longer-term forecasts but not in short-term predictions (Ho et al. 2008) and firms adopting ERP exhibit higher differential performance after two years (Nicolaou 2003). An important implementation characteristic is the scope of the implementation. It was discovered that greater functional and physical scope result in positive higher shareholder returns, firms that adopted multiple types of modules were more efficient in terms of employee utilization, and purchasers of a single module have greater returns than non-purchasers and even greater returns for purchasers of multiple modules (Hitt et al. 2002; Nicolaou 2004; Ranganathan and Brown 2006). Other implementation characteristics such as larger vendors and having system-led objectives were found to enhance a firm's ability to generate returns relative to firms following a different implementation strategy (Nicolaou 2004). Finally, positive reaction to initial ERP announcements was found to be the most positive for small and healthy firms (Hayes et al. 2001; Hunton et al. 2002).

At the process level (both paths 2 and 3), a set of factors have also been considered. First, implementation characteristics such as *customization*, *integration, optimization, alignment* of ERP with operational needs, interactions of ERP with other *complementary resources* such as supply chain management systems (SCM), business-to-business procurement (B2B), and total quality management (TQM), and *implementation scope* have been shown to be crucial to achieve operational benefits. For instance, it was found that customization, integration, and optimization exerted a significant influence on intermediate benefits (Davenport et al. 2004), which in turn affected the overall benefits (Chou and Chang 2008) while specific alignment within and between operational requirements and ERP structure was critical for performance (Bendoly and Jacobs 2004; Gattiker and Goodhue; Gefen and Ragowsky 2005; Kang et al. 2008). Also, it was discovered that operational benefits were obtained by firms using ERP systems in combination of other resources (Bendoly and Schoenherr 2005; Laframboise and Reyes 2005). Finally, a larger scope in terms of functional, geographic, and organizational scope was found to influence positively the outcomes of business process.

Second, firm characteristics such as *size*, *knowledge*, *history*, *business operating characteristics, organizational mechanism integration*, were found to be associated with achieving value from ERP. More specifically, firms with longer history, appropriate operational characteristics, efficient tasks, and greater knowledge of ERP usage had greater operational benefits (Bendoly and Schoenherr 2005; Chou and Chang 2008; Ragowsky et al. 2005). Larger firms reported improvements in financial measures whereas smaller companies reported better performance in manufacturing and logistics (Mabert et al. 2003). Finally, similar to firm level studies, *time* was also an important factor influencing the timescale over which operational benefits appear, i.e. a time lag exists between the implementation of an ERP and the realisation of benefits (Cotteleer 2006; Cotteleer and Bendoly 2006; McAfee 2002).

The aforementioned synthesis of the existing literature identifies some significant gaps in our understanding of the effect of ERP on performance at both the process and firm level. A better understanding of the methods by which different degrees of integration are achieved and their impacts on business value is needed to open up the black box of business value of ERP. Also, the aforementioned synthesis highlights major differences between this study and the existing literature. First, previous studies have focused on the impact of ERP as whole. ERP may be a one-size-fits-all application, but the benefits still depend on how well they address business needs. The benefit derived from an ERP system may be different for different modules (Gefen and Ragowsky 2005). In fact, not all organizations implement a full range of ERP modules. Some organizations may only implement one or two modules while others may implement the full ERP system. This essay therefore complements the assessment of ERP value as one package, despite the recognition that ERP systems are designed to integrate information across functions and processes, and looks at the impact of one ERP module on business process performance (Gefen and Ragowsky 2005).

Second, various factors have been shown to be important to explain mixed results and especially the role of integration (Davenport et al. 2004). However, a measure of the level of integration is missing, since most studies have looked at

ERP systems as a proxy of integration, thus undermining our understanding of the influence of different degrees of integration on performance. It would be simplistic to assume that examining which modules and/or the number of modules of an ERP system were implemented would tell us the degree of integration achieved. First, the level of integration of the ERP across different ERP vendors is not fully equivalent. Second, as ERP systems are modular and involve significant implementation complexity, not all implementations of the same ERP will necessarily obtain the same level of integration. Thus, a direct measure of different degrees of integration actually achieved for each module is used and the impact on business process performance is examined.

Finally, given that antecedents to ERP integration have received limited attention, the concepts of perceived gap, search, design, and alertness are included in the model to demonstrate how different degrees of ERP module integration are achieved. Based on the first essay, search and alertness are included in the model to demonstrate how integrative opportunities are identified while design is included as the second activity of the integration process. Furthermore, perceived gap, as an important variable in an ERP context, is included as an antecedent to search, design, and ERP module integration. Therefore, the business value of ERP is examined from an integration perspective to find out under what conditions the extent of integration is achieved and influenced the performance of business processes.

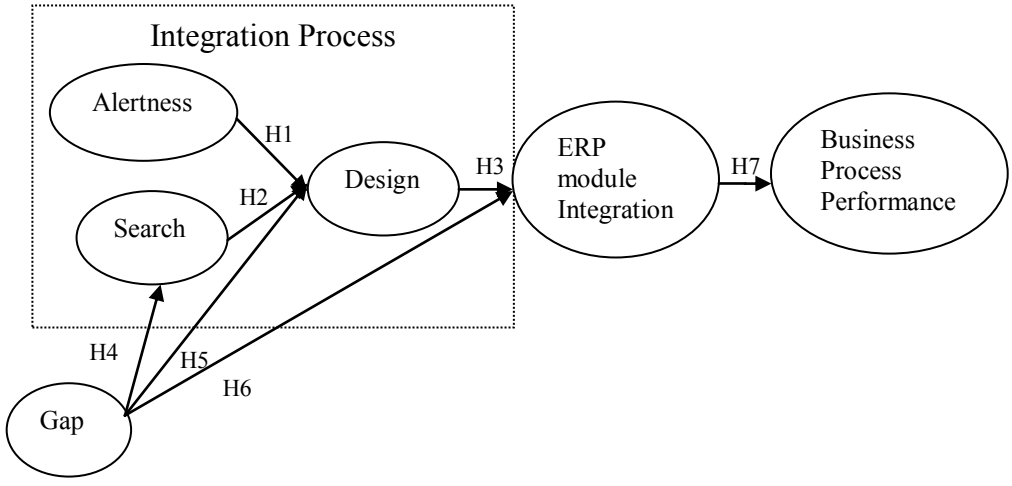
Theoretical Development

Research framework

ERP systems are deployed with the expectation of generating business benefits for the firm as a whole (Hitt et al. 2002). However, it is not enough to just deploy ERP. It is also necessary to integrate it into the firm's IT infrastructure and business processes (Barki and Pinsonneault 2005). Grounded in the first two essays, a research model is proposed (Figure 2). It is posited that ERP module integration is expected to depend on the integration process, which is composed of the identification of integrative opportunities through search and alertness and

their exploitation through design. Furthermore, search, design, and integration are expected to be influenced by the level of perceived gap. More specifically, a high gap is expected to necessitate a high level of search and design and be linked to low integration. Therefore, in order to increase the probability and enhance the integration of the ERP module, alertness, search, and design are required. The model also stipulates that the degree of ERP module integration will affect positively the performance of the business processes. As formal hypotheses are developed below, further justifications of the variables in the model are provided.

Figure 2. Research model



Hypotheses development

Integration process

Similar to the entrepreneurial process, the integration process is defined by two main activities: the identification and exploitation of integrative opportunities. Integrative opportunities are identified through search and alertness and then exploited by the design activity. Opportunities found during the identification activity are integrated to create capabilities that are intended to create value from ERP systems (Sirmon et al. 2007; Teece 2007). In some cases, these opportunities are objectively available to all, while in other cases, they require the insight to see that existing resources can be recombined in a new way that makes them more valuable (Butler et al. 2010). The identification occurs when someone

makes the assumption that a set of resources in not put to its "best use" (Shane and Venakataraman 2000). Before benefit can be found from an opportunity, managers must discover that it has value and then exploit it. Identification can be achieved either by being alert or searching for opportunities. The exploitation of opportunities involves the maintenance and improvement of business processes and complementary IT assets by designing appropriate solutions to achieve integration with the ERP system. Thus, the integration of ERP is composed of the identification, as a result of managers' alertness and search, and exploitation, via design, of integrative opportunities.

Alertness. ERP module integration can be understood in terms of managing opportunities to integrate the ERP module, its users, IT applications, and business processes. It is only when this occurs that the ERP system can be effectively integrated. These opportunities emerge from changing conditions, for example changes in technological conditions with the implementation of a new ERP module. Opportunities come into existence at a given point in time because of a combination of new conditions (Baron 2006). Some of these opportunities may be identified by individuals who possess a unique preparedness to recognize them (Kirzner 1979). The alertness perspective emphasizes the fact that opportunities can sometimes be recognized by individuals who are not actively searching for them. It is a perspective that helps some individuals to be more aware of changes, shifts, opportunities, and overlooked possibilities (Kirzner 1979). It refers to a unique preparedness to recognize opportunities when they exist (Gaglio and Katz 2001; Kaish and Gilad 1991). A heightened sense of alertness can allow an individual to pick up on previously unnoticed features of the environment. This underscores the need for managers involved in an ERP implementation to stay alert to unexpected situations for an effective integration of the ERP module. Therefore, before technological change leads to integrated processes and IT applications or more automated processes, managers must discover opportunities in which to exploit the new technology and extract benefits, and without alertness, opportunities may remain unnoticed (Shane 2000; Yu 2001).

It has been argued that the presence of alertness leads to an enhanced ability to notice unexpected opportunities (Gaglio and Katz 2001). The alertness of managers can be defined as the extent to which managers involved in the implementation of an ERP module can recognize opportunities without actively searching for them (Gaglio and Katz 2001; Kaish and Gilad 1991). This definition suggests that opportunities can be noticed even by managers who are not actively seeking them; indeed, when alertness is high, managers may engage in what has been termed "passive search," a state in which they are receptive to opportunities, but do not engage in a formal, systematic search for them (Baron 2006). By capitalizing on awareness of the opportunities and limitations of the new ERP module, alertness promotes the discovery of profitable discrepancies and gaps. It implies that managers will vary in their effort to identify integrative opportunities depending on the situation and their mindset.

Managers with the attribute of being alert will be more likely to identify opportunities that will allow them to achieve greater integration through high design activity (Tang and Khan 2007). When alertness is high, managers acquire information about new opportunities, invest resources to exploit them, and act proactively to innovate on a consistent basis. They are alert to misfit and recognize that resources are not being put to their "best use", and therefore, obtain the resources, and recombine them to get value, in this case, to achieve integration. Rather than considering only integrative opportunities consistent with previous implementation, alert managers will notice new ERP integrative opportunities, even if they are quite a departure from original plans. They will be less likely to miss an integrative opportunity just because it is too different from common experience and they will be aware that there are opportunities with the new ERP module. Additionally, alert managers will likely think "outside of the box" and identify many alternative opportunities, which should result in greater exploitation of these opportunities.

On the contrary, less alert managers will be more likely to overlook opportunities that are too different from what they are accustomed to or discount integrative opportunities, which would result in a low level of design and thus,

low integration. A source of information will tend not to be used or will be given less attention whenever managers are less alert. It has also been argued that managers tend to avoid anything that threatens their current perception or pattern of behavior (Gaglio and Katz 2001). In summary, alert managers will be more likely to take advantage of integrative opportunities that are relevant to the firm's context that may have a positive impact in the ERP integration. This leads to the following hypothesis:

Hypothesis 1: *Alertness is positively related to design.*

Search. The search perspective (Fiet, 2002; Fiet et al. 2004), argues that opportunities are discovered through systematic search in areas where managers are knowledgeable. Previous studies indicated that actively searching for information is an important factor in the identification of opportunities (Baron 2006; Fiet and Patel 2008). For example, managers may actively seek information about ERP opportunities from unique sources such as personal contacts or more specialized resources such as conferences or vendors' publications. Accordingly, managers who engage in search tend to transform prevailing information or knowledge in order to create new ways to integrate (Tang and Khan 2007).

Since the integration of ERP requires the identification of integrative opportunities, it is important that managers involved in the implementation of an ERP module pay ongoing attention to ERP- related integration opportunities. The integration of an ERP occurs as a result of taking advantage of multiple opportunities to further increase the integration between the ERP module and the current technological infrastructure and business processes. Because of this, one key process for the managers seeking to achieve a high degree of ERP module integration is to continuously monitor the appearance of new ERP integrative opportunities, by recognizing both emerging ERP-related organizational needs and current problems with existing processes and technology. This activity is called search and consists of the effort managers deploy to learn about their new work environments through different means such as self-exploration. This is similar to the concept of experiential interventions (Jones et al. 2008) where users

make the effort to learn about their new work environments by using and experimenting with the ERP module. Experiential intervention was found to be associated with increased software and work process understandings and greater installed ERP functionalities (Jones et al. 2008). This activity is also similar to the concept of environmental scanning (Aguilar, 1967; Maier et al. 1997), which is defined as the acquisition of information about events, trends, and relationships in an organization's environment. By searching for new integrative opportunities, managers will gain knowledge and understanding of the ERP module, its issues and features, which is expected to assist them in their task of integrating the new ERP module (Jones et al. 2008).

It is through ongoing search that managers become aware of new ERP integrative opportunities that, if acted upon, can enable more effective integration of the ERP module. Managers are more likely to become aware of ERP-related integration opportunities if they are engaged in search activity. For example, managers may be assigned to monitoring either the performance of current business processes or seeking out new ways to do things with the module. The managers can exchange information with colleagues in other areas of the organization in order to gather information about their work processes or tasks. Similarly, managers may read publications or attend vendor presentations for the purpose of monitoring new ERP trends (Jones et al. 2008). Managers that engage in these search activities are more likely to become aware of ERP integration opportunities that can be used to achieve higher levels of ERP integration.

Integrative opportunities identified through search are likely to have an effect on ERP module integration when they are realized by the organization, i.e. such that the opportunities are developed. Based on the entrepreneurial process, after identifying integrative opportunities through search, managers are more likely to achieve greater integration by engaging in the design activity to exploit these opportunities (Shane and Venkataraman 2000). Furthermore, it is suggested that managers who engage in a high level of search are also likely to engage in a high level of design. At the opposite, managers that do not engage in search activities, or that do so to a lesser extent, will be more likely to miss opportunities

to integrate their ERP modules and spend less energy in exploiting integrative opportunities. Therefore, it is proposed here that:

Hypothesis 2: *Search is positively related to design.*

Design. Some integrative opportunities are realized as a result of managers recognizing that current business processes are not as efficient as the current industry. In other cases, integrative opportunities are acted on because of current integration problems with the existing technology. To accomplish this, managers can change current business processes to adopt the ones provided by the ERP module or change the ERP module to add new functionalities or develop solutions to current technological problems. These mechanisms, which are referred to as *design*, include activities performed to take action on opportunities found. Therefore, design refers to the effort needed to modify the current business processes and/or the new ERP module.

The presence of design will increase the likelihood of the integrative opportunities leading to the more effective integration of the ERP module. As suggested by prior work (Rajgopal 2002), exploiting integrative opportunities is likely to lead to integration because a well-designed ERP has the capability to integrate the vastly ignored information with the popular administrative functions of an organization. This also implies that different sub-units of an organization will share the same information, which is available in real time, about various business functions in the organization. If design activities do not take place, the level of integration achieved is likely to be limited. As a result, the managers may promote a sub-optimal ERP module integration, one with marginal integration, or may hinder the realization of opportunities with potential impact on ERP module integration. Given that design has the capability to address integration, it is expected that design will positively affect ERP module integration. This leads to the following hypothesis:

Hypothesis 3: *Design is positively related to ERP module integration.*

Perceived gap

The best practices provided by the ERP module may not be appropriate for every processes of a business unit (Swan et al. 1999). Similarly, when implementing a new ERP module, it may be difficult to achieve the expected connections among the databases and activities related to a certain business process. Therefore, a gap is likely to be present between the actual way of working and what is proposed by the ERP module and influence different organizational outcomes. Here, *perceived gap* refers to the degree to which the business processes, data, and user interfaces of the ERP module are different than the actual way of working.

The gap perceived may stem from the firm, or country-specific, requirements that do not match the capabilities of ERP (Soh et al. 2000; Wang et al. 2006), the conflicting interests of user organization and ERP vendors (Swan et al. 2005), the assumption of universal best practices by ERP vendors (Wang et al. 2006), the greater differentiation between plants (Gattiker and Goodhue 2005), and the organizational structures of the implementing organization (Soh and Sia 2005). Existing research has documented that the gap between an ERP's standard processes and the organization's business conditions may influence the implementation process (Hong and Kim 2002; Luo and Strong 2004; Robey et al. 2002; Soh and Sia 2005; Wang et al. 2006). More specifically, a high gap was found to be negatively associated with successful implementations (Luo and Strong 2004; Robey et al. 2002) and perceived ERP system quality (Wang et al. 2006). Since one of the main characteristic of a successful implementation of an ERP is its integration, it is adequate to assume that the degree of perceived gap is also likely to influence the integration process (search and design) and the degree of integration of an ERP module. However, the gap is not expected to influence the level of alertness, since it is mostly a state that will be influenced by other contextual factors such as experience with ERP implementation.

Adopting an ERP system requires customizing certain solutions it offers to fit the firm's specific markets, structure, and operational requirements. Thus, when the gap is high between the current way of working and the new ERP module that is going to be implemented, changes to the business processes and/or

IT infrastructure are needed (Hong and Kim 2002; Luo and Strong 2004; Wang et al. 2006). For instance, an organization may have unique processes and managers will need to change their business processes to match the actual technology or change the technology to account for this uniqueness. Managers could also decide to implement the best practices embedded in the ERP module to have business processes similar to competitors in the industry. Since new opportunities are likely to emerge from these changes, managers are also likely to engage in high level of search activity, to find integrative opportunities, and design activity, to exploit these opportunities. Thus, the gap is likely to generate different levels of search and design.

In case of large gap, more opportunities for integration are likely to emerge, which will require high level of search and design from managers involved in the ERP implementation. More specifically, because many changes to the current way of working and/or new ERP module are needed, managers will have to look for ways to innovate with the ERP module and exploit those opportunities. Managers are likely to focus on major or radical improvements and innovations with the system and/or their business processes (Fichman 2004; Ranganathan and Brown 2006). To do so, they are likely to engage in high level of search activity to find out what other departments or organizations have been doing with similar modules or look for ways to improve their business processes and innovate with the technology (Jones et al. 2008). They will also make changes to the current way of working and have to engage in high level of design. On the other hand, when a small gap is perceived, opportunities are likely to be defined as incremental, where the level of search and design needed is not as important as when the gap is high (Tang and Khan 2007). The utility of search and design are attenuated because the explicit integration of the ERP module reduces the necessity of these activities. Thus, the gap perceived by managers is a trigger that will influence the level of search and design performed by managers.

The idea that search will depend on the level of perceived gap is similar to the concept of exploitation/exploration where a greater amount of search denotes a higher exploration orientation (March 1991; Sidhu et al. 2007). Exploration is

search for new knowledge and use of unfamiliar technologies, while exploitation is use and refinement of existing technologies and processes (Greve 2007). Therefore, when a new ERP module is implemented and a large gap is perceived, exploration of new opportunities is likely to occur through high search, while when a low gap is perceived, exploitation of current capabilities with limited search is likely to occur. These considerations lead to the following hypothesis:

Hypothesis 4: *Perceived gap is positively related to search.*

The concept of design being influenced by the level of perceived gap corresponds to the idea of customization previously studied in ERP research, where the primary goal is to achieve a fit the ERP module and the processes that system supports (Gattiker and Goodhue 2005; Luo and Strong 2004; Wang et al. 2006). Exploiting integrative opportunities through design may be an effective strategy for dealing with the unique needs of a business unit in case of high gap. Therefore, it should be expected that when the gap is high, higher level of design should be needed. This leads to the following hypothesis:

Hypothesis 5: *Perceived gap is positively related to design.*

Similarly, it should be expected that when the gap is high, lower level of integration should be present unless changes to the module or current way of working are made by identifying and exploiting integrative opportunities. Indeed, previous literature has shown that perceived gap is negatively related to ERP implementation (Luo and Strong 2004). Conversely, when perceived gap is low, greater integration should be achieved because fewer opportunities for integration are likely to be present, i.e. the current way of working presents a level of integration similar to what is proposed with the new ERP module. This leads to the following hypothesis:

Hypothesis 6: *Perceived gap is negatively related to ERP module integration.*

The impact of ERP module integration

Business process improvements have always been major motivations for ERP implementation (Rajagopal 2002). However, research on ERP and performance

has suggested that ERP must be integrated before it can exhibit any significant business value (Ragananthan and Brown 2006; Volkoff et al. 2005). The aim of integration is to reduce incompatibility between systems and business processes and enhance responsiveness of the systems (Goodhue et al. 1992). Evidence from the literature suggests that integration helps improve performance by reducing cycle time, improving customer service, and lowering procurement costs (Barua et al. 2004). It also helps speed up communications, improve decision-making, and links firms more easily with their customers and suppliers (Davenport et al. 2004). In contrast, unintegrated systems can create various kinds of problems for companies (Markus 2000). For instance, lack of integration can hinder the ability to analyze data for making important decisions, put in place streamlined business processes, efficiently obtain needed reports or respond quickly to customers' demands (Markus 2000; Markus 2001).

Integration is critical for ERP because it requires streamlined data flows along the value chain and automatic communication across processes (Zhu and Kraemer 2002). For this reason, ERP module integration is important to firms and refers to the extent to which the components of an ERP module are tightly coupled with relevant business processes and IT applications. Integration can replace functionally oriented and often poorly connected legacy software, resulting in savings in infrastructure support costs. Furthermore, improvements in integration enabled by ERP can affect the entire organization and therefore can positively impact performance. Thus, modules with higher degrees of integration tend to enjoy advantages and are more likely to achieve greater performance of their business processes.

The process-oriented perspective is useful for identifying various ways ERP module integration can provide business value either via existing or planned IT systems (Karimi et al. 2007; Mooney et al. 1995). Rather than looking at the level of a firm's output measures for determining business value, the process-oriented perspective favors process-oriented assessment of ERP business value. Therefore, it is reasonable to assume that there is a positive relationship between

extent of ERP module integration and a firm's business process performance, which leads to the following hypothesis:

Hypothesis 7: *ERP module integration is positively related to business process performance.*

Method

Instrument development

A survey instrument was developed to measure the constructs needed to test the above hypotheses. Previous approaches to develop and validate instruments were used (Churchill 1979; Moore and Benbasat 1991). In order to develop clear definitions of the constructs and their interrelationships in a well-specified theoretical context, relevant bodies of literature were reviewed. Questions from existing scales were borrowed from existing literature for perceived gap (Hong and Kim 2002; Wang et al. 2006), while questions for ERP module integration and business process performance were developed based on Essay #2. Finally, questions were developed for alertness, design, and search based on previous research (Galigo and Katz 2001; Jones et al. 2008).

Items generated for search, design, and alertness were submitted to two rounds of a card-sorting test (Moore and Benbasat 1991). For each round, 10 different PhD students in information systems grouped the list of items into pre-defined categories. For the first round, 8 items related to search, 3 items related to design, and 7 items related to alertness were used for the card-sorting test (see Table 1). However, after the first round, it was necessary to modify some items in order to improve the clarity and comprehension of the words used, add items, or delete items. More specifically, items that did not show average agreement above 0.80 were deleted or modified. A total of three items were deleted (two search and one alertness), four items were modified (2 search and 2 alertness), and two items were added (design). For the second round, a total of 17 items were sent to card sorting and two items were further deleted (1 search and 1 alertness) for a total of 15 items; five for each construct. As shown in Table 1, the final sorting resulted in a satisfactory classification of the items into the three constructs of

search, design, and alertness, i.e. such that all items showed an average agreement above 0.80. Three items for each construct were selected for the final analysis.

Table 1. Final card sorting for search, alertness, and design

	Search	Alert	Design	Others	Avg Agree
Search: The managers involved in the implementation of the module:					
read publications about how other divisions/companies have implemented a similar module.	8	1		1	0.80
searched for ways to improve the business processes of the module.	8	1		1	0.80
talked to others in their divisions about how their work processes or tasks are different in the module.	8	1		1	0.80
searched for ways to do things with the module that no one else seemed to know about.	8	2			0.80
looked at what other divisions/organizations were doing with the same module.	8		1	1	0.80
Alertness: The managers involved in the implementation of the module:					
were attentive to the unique needs of their unit and what opportunities the module could offer them.		10			1.00
were on the alert for new opportunities with the module.		10			1.00
felt the need to be alert at all times to new possibilities with the module.		10			1.00
were prepared to think about counterintuitive opportunities with the module.		8			0.80
were aware of new ways of doing the same work with the new module.	1	9			0.90
Design					
The business processes in our unit were modified.			9	1	0.90
Additional developments for the ERP module were needed.			10		1.00
The IT experts/consultants needed to develop alternative solutions to reduce the gap between the current business processes and the new business processes of the module.			9	1	0.90
The ERP module was altered to improve its fit with this plant.	1		8	1	0.80
When the ERP module was being implemented in this business unit, the package was changed to better meet the needs of this plant.			9	1	0.90

Data collection

Data were collected using a web-based survey that was developed and pre-tested by three managers involved in previous ERP implementations in order to improve face validity and make sure that the items were relevant to managers of existing organizations. The goal was to make the questionnaire more valid and reliable by clarifying, rephrasing, or eliminating problematic, obscure, and poorly answered items.

The revised questionnaire (see Appendix B) was then distributed to two different e-mail contact lists: (1) APICS (The Association for Operations Management) Education and Research Foundation and (2) IT data group. For the first, an initial e-mail was sent to managers to explain the purpose of the study and a link to an external website was provided. This website provided the importance of their participation and the link to the survey and promised them a summary of the research findings. One follow-up e-mail was sent by APICS a week after the initial e-mail. With regards to the IT data group, respondents were contacted first by email and the one that click on the link were directly contacted by phone to explain the purpose of the study and explain how to proceed with the online survey. In total, 254 surveys were returned (146 from APICS and 108 from IT data group) but incomplete surveys as well as aberrant responses with a uniform answer to the entire set of questions were excluded. A total of 148 answered surveys were used for the analysis, i.e. from 71 APICS and 77 from the IT data group.

Respondents

The sample included respondents from 11 different industries, with almost 65% from the manufacturing industry. The respondents were involved in 23 different types of modules from 5 different package vendors, with 17% involved in an MRP module and 51% SAP vendors. Almost all respondents had previous experience with an ERP implementation, with 68% of the respondents previously involved in more than 2 ERP implementation projects. Furthermore, 82% of the respondents were male, more than 91% were between 30 and 59 years of age, and

more than 85 % held at least a bachelor's degree. Thus, even though a non-random sampling approach was used, the sample contained a variety of industries, organizations and modules implemented (See Table 2).

Table 2. Demographics of Participants

Demographics		Frequency	Percentage
Gender	Men	104	70%
	Women	22	15%
	Not specified	22	15%
Manager's Role in the ERP implementation	Project Manager	20	14%
	Business Analyst	11	7%
	Integrator	8	5%
	Knowledge Worker	15	10%
	Super user	42	28%
	Team leader	8	5%
	Consultant	5	4%
	Program Director	4	3%
	More than 1 role	18	12%
	Not specified	17	12%
Tenure in Organization	Less than 2 years	11	7%
	2-5 years	42	28%
	6-10 years	33	22%
	10-20 years	19	13%
	More than 20 years	17	12%
	Not specified	26	18%
Manager's Previous Experience with ERP Implementation (# of implementation)	None	2	1%
	1	19	13%
	2	17	12%
	3	28	19%
	4	13	8%
	More than 5	26	18%
	More than 10	16	11%
	Not specified	27	18%
Education	High school degree	10	7%
	Collegial/technical degree	8	5%
	Bachelor degree	49	33%
	Master's degree	57	39%
	Not specified	24	16%
Age	20-29	2	1%
	30-39	25	17%
	40-49	42	28%
	50-59	46	32%
	60+	9	6%
	Not specified	24	16%

Finally, two checks for nonresponse bias were performed. First, incomplete surveys were compared to complete surveys. Second, late respondents

(after the follow-up e-mail was sent) with early respondents (after the initial mailing). No systematic differences were identified in either check, suggesting the absence of response bias.

Operationalization and measures

As shown in Table 3, a total of 22 items were used to test the research model. The operationalization of each construct is described below.

Alertness

Building on the work of Gaglio and Katz (2001), Alertness is defined as the extent to which managers can recognize opportunities that occur during the implementation of the module. It is conceptualized as a collective phenomenon. To measure the construct, we asked managers about their perceptions of the degree to which all managers involved in the implementation of the ERP module: (1) were alert to new opportunities with the module, (2) felt the need to be alert at all times to new possibilities with the module, and (3) were prepared to think about counterintuitive opportunities with the module. A five point Likert scale was used to gather their level of agreement on three items (strongly agree to strongly disagree).

Search

Search is defined at the extent to which managers engage in an effort to learn about their new work environments (both module and business processes) through different means such as experimenting with the module and self-exploration. Similar to alertness, it is conceptualized as a collective phenomenon. To measure the construct, we asked managers about their perceptions about the degree to which all managers involved in the implementation of the ERP module: (1) read publications about how other divisions/companies have implemented a similar module, (2) searched for ways to improve the business processes of the module, and (3) talked to others in their divisions about how their work processes or tasks are different in the module. A five point Likert scale was used to gather their level of agreement on three items (strongly agree to strongly disagree).

Table 3. Questionnaire items and descriptive statistics

Constructs	Items	Reliabilities & descriptive data
Alertness	1. Were on the alert for new opportunities with the module. 2. Felt the need to be alert at all times to new possibilities with the module. 3. Were prepared to think about counterintuitive opportunities with the module.	Mean = 2.395 Std. dev. = .939 α = .912
Search	1. Read publications about how other divisions/companies have implemented a similar module. 2. Searched for ways to improve the business processes of the ERP module. 3. Talked to others in their divisions about how their work processes or tasks are different in the module.	Mean = 2.377 Std. dev. = .967 α = .869
Design	1. Additional developments for the ERP module were needed. 2. The ERP module was altered to improve its fit with this plant. 3. When the ERP module was being implemented in this business unit, the package was changed to better meet the needs of this plant.	Mean = 2.540 Std. dev. = .967 α = .844
Perceived Gap	**Data** 1. The name and meaning of the module data items correspond to those of the documents used in our company (i.e. a sales order sheet, sales report). 2. The form and format data items of the module correspond to those of the documents used in our company. 3. The output data items of the module correspond to those of the documents used in our company.	Mean = 2.413 Std. dev. = 1.129 α = .797
	Business process 1. The processes flow built in the module correspond to flow of organizational processes. 2. The processes built in the module accommodate the change required from organizational processes. 3. The processes built in the module correspond to the business practices of our company.	Mean = 2.268 Std. dev. = .791 α = .770
	User Interface 1. User interface structures of the module are well designed to the work structure required for conducting business in our company. 2. User interface of the module is well designed to the user capabilities of our company. 3. User interface of the module is well designed to the business needs of our company.	Mean = 2.391 Std. dev. = .835 α = .906
ERP Module Integration	1. The module is integrated with the various IT applications in your unit. 2. The module with other IT applications has been combined into a functional whole or a unified system.	Mean = 2.3870 Std. dev. = .933 α = 0.815
Business Process Performance	1. The overall business process performance is high. 2. The operation of our business processes is high.	Mean = 2.3965 Std. dev. = .864 α = .966

Design

Design is defined at the extent to which modifications to actual business processes and/or the new ERP module were needed. To measure the construct, we asked managers involved in the implementation of the ERP module their perceptions about the degree to which: (1) additional developments for the ERP module were needed, (2) the ERP module was altered to improve its fit with this plant, and (3) when the ERP module was being implemented in this business unit, the package was changed to better meet the needs of this plant. A five point Likert scale was used to gather their level of agreement on these three items (strongly agree to strongly disagree)

Perceived gap

Perceived gap refers here as the extent to which the business processes, data, and user interfaces of the ERP module are different than the actual way of working (Hong and Kim 2002; Soh et al. 2000). Based on the work of Hong and Kim (2002), 9 items divided in three dimensions were adapted to measure perceived gap at the module level.

Business process gap was assessed by asking managers the extent to which the processes built in the module (1) correspond to flow of organizational processes, (2) accommodate the change required from organizational processes, and (3) correspond to the business practices of our company. For user interface, it was assessed by asking managers the extent to which user interface of the module was well designed to the (1) work structure required for conducting business in our company, user capabilities of their company, and (3) business needs of their company. Finally, data gap was assessed by asking managers the extent to which the (1) name and meaning of the module data items correspond to those of the documents used in our company (i.e. a sales order sheet, sales report), (2) form and format data items of the module correspond to those of the documents used in our company, and (3) output data items of the module correspond to those of the documents used in our company. All items were measured using a five point Likert scale anchored with “strongly agree” and “strongly disagree”.

However, as described above, these items measure fit instead of gap because it has been suggested that there is a general bias toward negative information (Rozin and Royzman 2001; Smith et al. 2006). Negative information, such as gap, tends to play a larger role in information processing and behaviour than does positive information. This bias can be eliminated when positive constructs are made accessible (Smith et al. 2006). Since all other constructs were positive and previous research has provided items of fit, the three dimensions of perceived gap were measured as fit and reverse coding was used in the analysis. Furthermore, the idea of the difference between the current way of working and the new ERP system has been defined with concepts such as misfit, gap, fit, and misalignment (Hong and Kim 2002;Soh et al. 2000; Wang et al. 2006).

Finally, previous studies (Hong and Kim 2002; Wang et al. 2006) have assessed perceived gap as one dimension with all items loading on the construct. However, based on an exploratory factor analysis using a Varimax rotation and eigenvalues greater than 1 (see Table 4), it was found that three dimensions composed perceived gap. Therefore, the construct of perceived gap was assessed as a second-order reflective construct. For analysis, items were aggregated at the dimensions level with 3 items measuring perceived gap: user interface gap, data gap, and business process gap.

Table 4. Factor pattern for perceived gap

	User Interface	**Data**	**Business process**
BP Gap1	.206	.287	**.763**
BP Gap2	.473	-.010	**.675**
BP Gap3	.111	.216	**.854**
Data Gap1	.153	**.769**	.173
Data Gap2	.221	**.858**	.091
Data Gap3	.136	**.796**	.205
UI Gap1	**.808**	.258	.324
UI Gap2	**.890**	.161	.197
UI Gap3	**.886**	.215	.134

ERP Module Integration

ERP module integration was assessed by the extent to which the components of an ERP module and its users are tightly coupled with relevant business processes, IT applications, and users. The two reflective items from the previous essay were used and measured using five-point Likert scales (strongly agree to strongly disagree).

Business process performance

Business process performance was assessed by the extent to which higher level of performance and operational efficiency of the business processes in the adopting business units were achieved. The two reflective items were measured using five-point Likert scales (strongly agree to strongly disagree).

Control variables

Two control variables were used in this study because of their potential impact on business process performance. First, firm size, as measured by the number of employees and second, functional scope, as measured by the number of modules implemented.

Results

Data analysis

A two-step data analysis was conducted. First, the measurement model and then the hypotheses were tested by fitting the structural model. Structural equation modeling (SEM) was adopted as the main data analysis method. More specifically, the usable data collected were analyzed using the maximum likelihood (ML) estimator in EQS 6.1 for Windows program (Bentler 2004), which places less stringent assumptions on the multivariate normality of the data (Byrd and Turner 2000). Missing data were treated using maximum likelihood estimation procedures.

Table 5. Intercorrelations among constructs

Constructs	CA	CR	AVE	(1)	(2)	(3)	(4)	(5)	(6)
(1) Alertness	0.91	0.84	0.64	***0.80***					
(2) Gap	0.80	0.77	0.53	.000	***0.73***				
(3) Search	0.87	0.85	0.66	.605	-.087	***0.81***			
(4) Design	0.84	0.84	0.64	.006	.249	.127	***0.80***		
(5) ERPM Integration	0.86	0.86	0.76	.001	-.735	.089	-.024	***0.87***	
(6) BP Performance	0.97	0.96	0.93	.001	-.591	.072	-.019	.804	***0.97***

The diagonal elements in ***italic bold*** are the square roots of the AVE. The off-diagonal elements are the correlations between constructs.

Measurement model assessment

To validate the measurement model, reliability and validity analyses were performed. First, reliability, which measures the degree to which items are free from random error and therefore yield consistent results, was assessed based on Cronbach's alpha (CA) and composite reliability (CR), which values should exceed the recommended threshold value of 0.7 (Nunnally 1978). Cronbach's alpha was measured with SPSS, while composite reliability was measured using the standardized loadings of EQS output. As shown on Table 5, all constructs exhibited good reliability.

Table 6. Cross-Factor loading

	Gap	Integration	Design	Search	Alert	Performance
Data gap	**.786**	.176	-.144	.041	.002	.107
BP gap	**.639**	.213	-.183	.156	.121	.414
User gap	**.839**	.112	.021	-.029	.125	.148
ERPMI 1	.259	**.735**	-.131	.076	.176	.389
ERPMI 2	.247	**.881**	.034	.164	.126	.146
Design 1	-.157	-.160	**.820**	.052	.006	.077
Design 2	.045	.078	**.894**	.070	-.028	-.060
Design 3	-.104	.012	**.885**	-.011	-.051	.030
Search 1	.162	-.021	.057	**.888**	.099	.169
Search 2	-.027	.261	.133	**.768**	.403	.027
Search 3	-.041	.105	-.025	**.845**	.250	.204
Alert 1	.030	.169	-.122	.300	**.811**	.213
Alert 2	.059	.087	-.007	.180	**.912**	.184
Alert 3	.143	.053	.005	.159	**.899**	.046
BPP 1	.228	.233	.034	.190	.194	**.870**
BPP 2	.268	.185	.081	.220	.205	**.868**

*The factor analysis was conducted using a Varimax rotation and eigenvalues greater than 1.

Second, convergent validity, which assesses the consistency across multiple constructs, was confirmed by examining both the average variance extracted (AVE) and the factor loadings of the indicators associated with each construct. The AVE values should be above the threshold value of 0.5 (Fornell and Larcker 1981) and standardized loadings of items above a cutoff of 0.30 (Byrd and Turner 2000). Tables 5 and 7 show that these conditions hold.

Third, discriminant validity, which refers to the extent to which different constructs diverge from one another, was assessed by comparing (1) cross-loadings of all indicators, which should have a higher loading in defined construct than in any other construct and (2) the square root of the AVE for each construct against the inter-construct correlation estimates, which requires that the diagonal elements be greater than the off-diagonal elements (Fornell and Larcker 1981). All constructs showed discriminant validity (see Table 5 and 6).

Table 7. Factor loadings

Item	Standardized Factor loadings	t-value
Data gap	.655	7.00
Business gap	.826	8.32
User gap	.689	NA
ERPMI 1	.780	10.20
ERPMI 2	.955	NA
Design 1	.749	NA
Design 2	.822	9.50
Design 3	.834	9.87
Search 1	.688	NA
Search 2	.975	8.81
Search 3	.738	11.01
Alert 1	.725	NA
Alert 2	.760	10.36
Alert 3	.900	11.24
BPP 1	.970	NA
BPP 2	.962	23.60

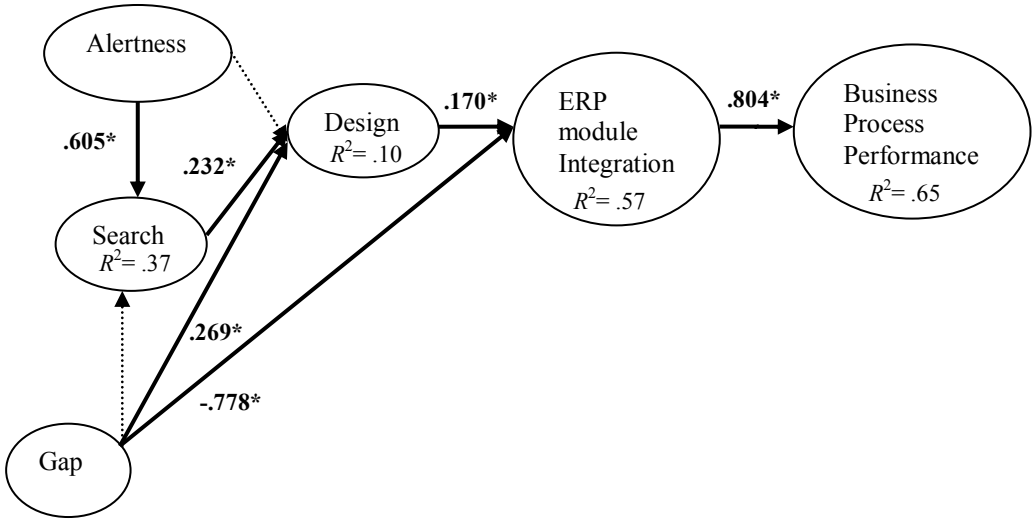
Consistent with structural equation modeling recommendations (Winklhofer and Diamoantopoulos 2002) overall fit was assessed based on

normed chi-square ($_X^2$/d.f.), which should be <2.00; NFI (normed-fit index), NNFI (non-normed fit index), CFI (comparative-fit index), and GFI (goodness-of-fit index), which should be above 0.90, RMSEA (root mean-square error of approximation) between 0.05 and 0.08 and less than the upper threshold of .10, and SRMR (standardized root mean-square residual). Estimation of the measurement model resulted in a good fit statistic with all indicators above their threshold number, except for SRMR (χ^2= 152.29; df = 83; p = 0.00001; NFI= 0.91, NNFI = 0.94, CFI = 0.96, GFI = 0.90; SRMR=0.14; RMSEA = 0.07).

Structural model assessment

The hypotheses were tested by examining the magnitude and significance of structural paths in the EQS output and the percentage of variance explained in endogenous variables, which are reported in Figure 3. Based on LMTest results and supported by the literature, one new path was added between alertness and search, which improved the fit of the model and helped explain the non-significant link between alertness and design. Therefore, the link between alertness and design is mediated by search. Significant paths are in bold in Figure 3, while non-significant ones are in smaller font.

Figure 3. Structural model



* Significant at p<0.05

The assessment of the structural paths showed that alertness does not influenced design directly (beta = -.135; *t*-value = -1.248; *n/s*), which provides no support for Hypothesis 1 (see Table 8). However, a new path was added between alertness and search, which provided support for an indirect link between alertness and design. This link between alertness and search was thus positive and significant (beta = .605; *t*-value = 5.747; $p < 0.05$). The link between search and design was also significant (beta = .232; *t*-value = 2.003; $p < 0.05$), supporting hypothesis 2. The effect of design on ERP module integration was found to be significant (beta = .170; *t*-value =2.390; $p < 0.05$), supporting Hypothesis 3. The link between perceived gap and search was not significant (beta = -.087; *t*-value = -1.172; *n/s)*, which provides no support for Hypothesis 4. However, perceived gap was found to influence design (beta = .269; *t*-value =2.652; $p < 0.05$), which supports Hypothesis 6. The impact of perceived gap on ERP module integration was also significant (beta = -.778; *t*-value = -7.550; $p < 0.05$), supporting hypothesis 6. Hypothesis 7 was supported; ERP module integration is positively related to ERP business process performance (beta = .804; *t*-value = 8.734; $p < 0.05$), which explained 65% of the variance of business process performance. Overall, 57% of the variance of ERP module integration was explained by alertness, search, design, and perceived gap while 37% of variance of search was explained by alertness and perceived gap and 10% of the variance of design was explained by alertness, search, and perceived gap. Finally, firm size and functional scope, the two control variables, had no effect on business process performance.

Table 8. Results by hypothesis

Hypothesis		**Standardized path coefficient**	***t*-value**	**Supported**
H1	Alertness –> Design	-.135	-1.248	No
H2	Search–> Design	.232	2.003	**Yes**
H3	Design–> Integration	.170	2.390	**Yes**
H4	Gap–>Search	-.087	-1.172	No
H5	Gap–> Design	.269	2.652	**Yes**
H6	Gap –> Integration	-.778	-7.550	**Yes**
H7	Integration–> Performance	.804	8.734	**Yes**
New path	Alertness –>Search	.605	5.747	

Discussion

It has been argued that antecedents and impacts of ERP integration deserve deeper theoretical development and empirical validation. To address this issue, a model of ERP integration at the module level was developed and tested. The model showed that among managers who have been involved in implementing an ERP module, their alertness, search, design, and perceived gap explained a good amount of the variance in the overall level of ERP module integration (R^2 =0.57, Figure 3). More specifically, ERP module integration increases with the amount of design, while it decreases with the amount of perceived gap. Therefore, when managers recognize that the processes within their ERP module are not well aligned with the business processes that the business unit desires, lower ERP module integration is achieved. However, greater integration is achieved when managers engage in the integration process, which is composed of search and design activities and alertness to integrative opportunities.

Based on previous literature, the positive link between perceived gap and design is well supported. Making changes to an ERP module may be a response to a lack of fit between the business unit's processes and those embedded by the ERP package. Therefore, designing appropriate solutions to exploit integrative opportunities may be an effective strategy for dealing with unique needs of a business unit. Also, integrative opportunities are exploited through design when they are identified by managers searching for them. Alert managers may influence the design activity indirectly by achieving a higher level of search. Finally, search, alertness, and perceived gap explained a limited amount of variation in the design activity (R^2 =.10, Figure 3), suggesting that other factors may influence the level of design. Another explanation for the limited amount of variance explained could be related with the way the construct of design has been measured. Although the construct was built based on previous literature, empirical testing of the constructs is limited, suggesting areas for improvement.

It was suggested that the level of search would be influenced by the level of perceived gap. Although a significant amount of variation in search was

explained (R^2 =.37, Figure 3), the results do not show that. Instead, the level of search increases significantly with the level of alertness. It is possible that variations in perceived gap across managers were not important enough to increase the value of search. Therefore, managers that stay on the lookout for integrative opportunities are also likely to engage in high level of search for integrative opportunities, but not necessarily when there is a high gap.

Finally, a substantial amount of the variance in the predictor of process level benefits was explained (R^2 =0.65, Figure 3). Thus, the study shows that the examination of business value of ERP through the lens of integration provides a sound analysis of business process performance.

Contributions to research

This study provides a complementary perspective on ERP integration and contributes to research on the antecedents and performance effects of ERP integration in four main ways. First, it represents one of the first empirical studies of a module perspective of ERP integration. The majority of published ERP-integration research (Cotteleer and Bendoly 2006; Gattiker and Goodhue 2005; Hitt et al. 2002; Karimi et al. 2007; Ranganathan and Brown 2006; Volkoff et al. 2005) has focused on measuring the link between ERP integration and performance at the firm level and has looked at the scope of ERP systems as a proxy of integration, thus undermining our understanding of the influence of different degrees of integration on performance.

Second, previous ERP studies have provided valuable findings into the importance of integration, but there is also a need to place the ERP integration phenomenon in the context of existing theoretical frameworks and to generate and test hypotheses. A cross-sectional study that investigates relationships posited by previous entrepreneurship and ERP researchers was proposed. More specifically, it has been suggested by entrepreneurship scholars that the identification and exploitation of opportunities should affect the creation of future goods and services (Shane and Venkataraman 2000). This idea was applied to

understand the process to achieve ERP integration. This study confirms the relationships posited by previous research.

Third, the development of a measure of alertness in an ERP context is also an important contribution to the literature on entrepreneurship and information systems. The role of alertness has been emphasized in the literature, but limited empirical research has been conducted, especially in the IS literature (Gaglio and Katz 2001). Although the measure proposed could benefit from additional testing and refinement, the results of this study have shown that alertness plays an important role in the identification of integrative opportunities and subsequently the integration of an ERP module. Thus, this study contributes to both the literature on alertness and IS by providing a sound measure of the construct and empirically testing its role in an information system setting. IS researchers should benefit from incorporating the construct of alertness where the role of managers is important such as the implementation and deployment of information systems.

Finally, the addition of perceived gap as antecedent to ERP module integration and the integration process (i.e. search and design) adds to the body of ERP-gap research. This stream has mainly focused on the sources, types, and impacts of gap on various implementation and customization outcomes. The results of this study contribute to this literature by looking at gap at the module level and its impact on the integration process and degree of integration. It suggests, therefore, that different gaps may exist within the same organization, i.e. for different modules, and it is an important factor in the integration of an ERP module and the level of design.

Contributions to practice

It was argued that ERP integration is of great importance to firms, but less than half of those that implement such systems are able to achieve it. While there is already some evidence (e.g. the studies of Karimi et al. 2007, Ragananthan and Brown 2006, and Volkoff et al. 2005) that integration is important to achieving benefits from ERP, executives will also want to understand important factors influencing it and how to achieve such integration. The model proposed in this

study explains much of the variation in how to achieve ERP module integration among business units that have implemented an ERP module.

The influence of the integration process (search, alertness, and design) suggests that it is a mistake to expect to achieve integration automatically from successfully implementing an ERP module, even though these benefits are highly advertised by vendors. The level of search, alertness, and design varies among and within organizations; therefore, the potential for reaping integration-related benefits from an ERP module varies as well. Specifically, opportunities to achieve integration are first identified through search and alertness and then exploited through design. Furthermore, top management and members of ERP projects should create an environment that fosters awareness, where managers are encouraged to be alert to new opportunities with the module and search for new ideas about the integration of the ERP module. This would allow managers to be attentive to unique needs of their unit and the opportunities the ERP module can offer in terms of integration. Situations where leaders perceive that there is only one way to implement the system may discourage managers to stay alert to new possibilities with the system and search for integrative opportunities and thus invest less in exploiting opportunities and achieving integration.

The findings for perceived gap show that an ERP module can create operational difficulties through low integration for a business unit. The results suggest that top executives and IS managers should not dismiss managers who claim that their way of working is different than the best practices embedded in the ERP module. While it was not found that perceived gap influences search, it was found that it has an effect on design. This is important since changes to an ERP module have often been seen as a negative outcome of an ERP implementation (Mabert et al. 2003). Thus, managers who consider modifying the systems to take into consideration integrative opportunities should better integrate their ERP module.

Limitations and future research

This paper has some limitations that are worth mentioning. First, the use of a single respondent to provide survey data raises concerns of common method bias. To rule out this possibility, this issue was addressed by including protection of respondent anonymity, ensuring statements relating to dependent variables were not located close to the independent variables on the questionnaire and reducing evaluation apprehension, and so they were less likely to provide answers based on how they think the researcher would want them to respond (Podsakoff et al. 2003). In this respect, participants in this dissertation research were aware that the study was conducted by a reputable research university, there were no right and wrong answers, they could stop at any time, and their anonymity was explicitly guaranteed in the survey invitation letter. As a matter of fact, many participants did anonymously while others identified their companies but not themselves. Some participants identified other members of their organizations that could be potential participants in the survey while some agreed to identify themselves to participate in a prize drawing. In general, they had full control of their degree of anonymity. Second, it has been suggested that it is possible to reduce common method bias through the careful construction of the items themselves (Tourangeau et al., 2000). In this respect, the survey instrument was submitted to several rounds of pre-tests and tests prior to its use. Finally, the Harman's one factor test (Podsakoff et al., 2003) was also conducted. All statements relating variables were explored in a single exploratory factor analysis to check whether one component accounted for most of the variance. Results of the analysis indicate that four factors with eigenvalues greater than 1.00 combined account for 71.7% of total variances, while a factor with the greatest eigenvalue explains 24.68%. Since a single factor did not emerge or account for most of the variance, these results suggest that common method bias is unlikely to be a significant issue in this study.

Although single respondents are a valid reason for concern, the attention to detail in the pre-test stage of the survey, the guarantee of anonymity to decrease survey anxiety, and the use of the Harman's test suggest that although

common method bias cannot be totally ruled out, it is not a likely explanation for the research findings of this dissertation. Regardless, a greater ability to generalize results could be obtained by replicating key elements of the research models using multiple respondents for the same module, which should be the focus for future research. Indeed, the study looked at alertness, search, and design at the team level, but only measured through the perception of one manager. It is possible that some individuals had a deformed perception of the managers involved in the ERP in terms of alertness, search, and design.

Second, another important issue in this type of research is to understand the importance of nonresponse bias in the study. From the approached participants who did not fill in the research instruments, it is not possible to know if they did so due to the fact that they did not receive the surveys and reminders, they lacked time or simply because they did not feel comfortable participating in the study. This last reason is important because it may be argued that there will be a better chance that a participant from a firm with a successful ERP system may be more inclined to participate than one where the ERP has been a disaster. So, there may be a nonresponse bias in this study. Therefore, future research should be done in a longitudinal design where perceived gap, alertness, search, and design are first assessed while the system is being implemented and ERP module integration and performance variables are assessed after the system has gone live. In addition, it would be also interesting using the longitudinal design to see the role of alertness, search, and design after the system has gone live, i.e. if managers continue to identify and exploit integrative opportunities. There seems to be more research needed on IS continuance.

Third, the measure of perceived gap considers the role of this variable generally, i.e. that each dimension was aggregated. Including measures that distinguished between different types of gaps (user interface, business process, and data) would have increased our understanding of perceived gap and may have increased the likelihood of detecting a stronger statistical effect of perceived gap, specifically on search. With a bigger sample size, such a test could be done. Indeed, the sample size of 148 surveys is acceptable for this type of study but in

order to test for a more defined measure of ERP module integration, as proposed in Essay #2, sample size needs to be improved. Therefore, future research should be done to collect more data, which should allow looking at the effect and consequence of the dimensions of perceived gap and ERP module integration (disaggregated level).

Conclusion

The ERP findings of past research have made it increasingly clear that integration through ERP deserves serious research attention because of the potential for benefits and costs. Yet, the scarcity of theoretical frameworks and empirical studies on the antecedents and impacts of ERP integration has limited our understanding of the phenomenon. In this study, a model of the antecedents and performance effect of ERP integration at the module level was developed and tested. The relationships between ERP module integration and business process performance as well as four antecedents search, alertness, design, and perceived gap were studied. The analysis of data from 148 ERP module implementations supports the notion that ERP module integration positively influences the performance of the business processes, while the integration process and perceived gap are key antecedents to the integration of an ERP module. This research contributes to the current body of research on integration in general and ERP in particular by providing an empirical demonstration of the key drivers of ERP module integration and its impact on the performance of business processes. The results of this research should enhance our understanding of the integration patterns and the impact on the business value of ERP.

References: (see the end of the thesis)

Appendix A: Empirical Studies that Examine the Link between ERP and Performance

Reference	Findings	Dependent Variables	Measures and contextual factor
Path 1: Firm Level			
Hayes et al. (2001)	Positive reaction to initial ERP announcements, most positive for small/healthy firms.	Market returns	ERP Announcements Contextual Factors: size and Financial health
Poston and Grabski (2001)	No significant improvement in SG&A or RI 3 years following implementation, but improvements in firm performance (decrease of cost of goods sold) 3 years after implementation and 1,2, and 3 years for reduction in the number of employees.	SG&A Cost of goods sold Residual income Number of employees	Accounting measures Contextual Factors: Time
Hitt et al. (2002)	Firms that invest in ERP tend to show higher performance across a wide variety of financial metrics.	Productivity, firm performance, and stock market valuation	Accounting and market measures. Contextual Factor: Functional scope
Hunton et al. (2002	Significant difference in forecasts due to ERP announcement. Revisions most favorable to small/healthy firms.	Revision of earnings forecasts after announcement of ERP implementation	ERP announcements Contextual factors: size and financial health
Hunton et al. (2003)	ROA, ROI, and ATO were significantly better over a 3-year period for adopters, as compared to nonadopters.	ROA, ROS, ATO, ROI	Accounting measures Contextual factors: time
Nicolaou et al. (2003)	Firms adopting enterprise systems exhibit a significantly higher overall differential performance since the second year after adoption than a matched control group. A decomposition of overall performance into profitability and efficiency financial indicators shows that significant differences attained by the ERP adopting firms are due to higher profitability but not efficiency.	Profitability and efficiency	Accounting measures Contextual factor: time
Nicolaou (2004)	Firms adopting ES exhibit higher differential performance only after two years of continued use.	Financial performance (ROA , ROI, OIA, ROS, OIS, SGAS, COGS, ES)	Accounting measures Contextual factors: time, vendor choice, implementation goal, modules implemented

Ranganathan and Brown (2006)	ERP with greater functional and physical scope result in positive, higher shareholder returns.	Stock market return	ERP announcements Contextual factors: functional and physical scope.
Hendricks et al. (2007)	ERP improve profitability but not stock returns	Stock return, ROA, ROS,	ERP announcements
Ho et al. (2008)	Significantly positive revisions occur in longer term forecasts but not in the shorter term prediction such as one- and two-year ahead forecasts. Weak evidence that financial analysts react less positively to middle adopters than to early or late adopters.	Earnings forecasts	ERP announcements Contextual factors: time
Path 2: Business Process Level			
Booth et al. (2000)	ERP users report high levels of information integration for many functional areas, which is similar to that of non-users. ERP systems seem to perform better in transaction processing and ad hoc decision-support than in sophisticated decision-support and reporting. ERP systems were found to have little influence on the use of new accounting practices.	Information integration Information systems quality: transaction processing, reporting, and decision support. Use of new management practices	Accounting measures
McAfee (2002)	Evidence of a causal link between IT adoption and subsequent improvement in operational performance measures as well as evidence of the timescale over which these benefits appear.	1. fraction of orders shipped late 2. avg. lead time 3. SD of lead time for all orders	Operational measures (orders related) Contextual factors: Time
Akkermans et al. (2003)	Modest role for ERP in improving future supply chain effectiveness.	Supply chain effectiveness	Supply chain.
Mabert et al. (2003)	Larger companies report improvements in financial measures whereas smaller companies report better performance in manufacturing and logistics.	Efficiency and effectiveness	Key operating areas Contextual factors: size
Bendoly and Jacobs, (2004)	Alignment of ERP solutions w/operational needs is crucial to perceived ability to deliver orders on time and to general satisfaction with the ERP solution.	Performance (orders on time, personal satisfaction and transactional efficiency)	Operational measures (orders related) Contextual factor: alignment
Davenport et al. (2004)	The factors most associated with achieving value from ES are integration, process optimization, and use of ES data in decision-making.	Perceived business value	Perceived value measures Contextual factor: integration, informate, and optimization.

Bendoly and Schoenherr (2005)	Firms using ERP systems reap greater savings through B2B procurement than firms without ERP systems. Firms w/longer history and greater knowledge of ERP usage have greater savings through such e-procurement.	Procurement cost	Operational measures (Procurement) Contextual factor: history, knowledge, complementary resources.
Laframboise and Reyes (2005)	ERP implementation influences competitive position and performance through interactions w/other resources.	Improved quality level in supply chain	Contextual factor: complementary resources (TQM).
Ragowsky et al. (2005)	Organizational characteristics mediate the relationship between IS and the value ERP can add to the organization' primary activities.	Value added to organizational activities	Contextual factor: organizational characteristics (operating conditions).
Spathis and Ananiadis (2005)	ERP significantly contributes towards increased flexibility in information provision and improved decision making.	Perceived benefits Managerial Operational IT infrastructure	Dimensions of benefits Contextual factors: pre vs post-implementation
Cotteleer (2006)	Findings demonstrate parity in operational performance immediately following ES deployment. Parity was not a long-run consequence of the ES deployment	Order lead-time Elapsed time between receipt and shipment	Contextual factor: time
Cotteleer and Bendoly, (2006)	ERP initiative showed a significant improvement immediately after system deployment. System implementation gave rise to an ongoing trend of performance improvement, in contrast to a stable performance trend prior to go-live.	Lead-time reduction	Contextual factor: time
Karimi et al. (2007)	The extent of ERP Implementation (functional, geographic, and organizational scope) influences business process outcomes, and both ERP radicalness and delivery system play moderating roles.	Process efficiency Process Flexibility Process Effectiveness	Operational measures (business process performance) Contextual factors: ERP delivery system, ERP radicalness (moderator)
Kang et al. (2008)	Organizational integration modes need to be aligned with ERP systems for positive results from the ERP investment.	Operational efficiency (inventory cost, purchase cost, process cycle time)	Contextual factor: alignment

Path 1 and 2: Business process and firm levels			
Gefen and Ragowsky (2005)	The benefit from ERP investments is explained better by org. business characteristics when examined at a specific ERP module level.	ERP as a whole (overall benefit, profitability, market competition, cost reduction) Specific module (COM and S&PO)	Contextual factors: organizational characteristics
Path 2 and 3: Business process and firm levels			
Gattiker and Goodhue (2005)	ERP will be a relatively better fit when interdependence is high and differentiation is low.	Task efficiency Coordination improvements Overall business performance	Operational measures (manufacturing) Contextual factor: alignment
Matolcsy et al. (2005)	The adoption of ERP systems leads to sustained operational efficiencies and improved overall liquidity. Increased profitability 2 years after adoption and improvement in accounts receivable management.	Operational and overall performance Inventory turnover Fixed assets turnover Efficiencies Profitability and liquidity	Operational performance of value chain an d accounting measures Contextual factor: time
Vemuri and Palvia (2006)	For a majority of the firms improvement of operational performance expected due to ERP systems did not materialize.	Business processes Day-to-day operations Profitability, ROI, market valuation	Operational efficiency Market and financial measures
Chou and Chang (2008)	Customization improvement and task efficiency affect intermediate benefits, which in turn influence overall benefits.	Intermediate benefits (coordination improvement and task efficiency) Overall benefits (overall performance, success, positive effect)	Contextual factors: customization and organizational mechanisms
Path 1, 2 and 3 : Business process and firm levels			
Wieder et al. (2006)	No significant performance differences between ERPS adopters and non-adopters, neither at the supply chain level, nor at the overall firm level.	KPI for supply chain and firm performance (ROI, operating profits, sales growth rate, cost reduction, cash-flow).	Supply chain performance and accounting measures Contextual factors: time, experience, complementary resources (SCM),

Chapter V: Conclusion

Synthesis

The integration of information systems such as ERP has captured the interest of both researchers and practitioners in several disciplines such as Information Systems, Operations Management, and Manufacturing. The main reason for such interest is that the integration of ERP systems offers opportunities to achieve greater benefits for firms implementing them. Yet, the process of integration and the measurement of ERP integration have received little attention and the performance of ERP through integration still deserves greater theoretical development and empirical investigation. The goal of this thesis was to contribute to the research on ERP in general and integration in particular by looking at this phenomenon through three complementary essays. The combination of the three essays offers a valuable synthesis of the current body of research as well as new insights concerning how ERP integration can be achieved and lead to greater performance. The next section provides a brief summary of each essay.

Essay #1

In the first essay, an exploratory model of the first step of the process to achieve ERP integration was developed and validated through four cases. The goal was to integrate the literature on entrepreneurship and ERP to look at the identification of integrative opportunities as the key activity of the integration process. The model proposed that the identification of opportunities is composed of the search for and alertness to opportunities. Furthermore, it was proposed that search depends on the gap perceived by managers. Four types of identification were proposed by combining the two extreme cases of alertness and search (high or low). Results show that when managers are alert and engage in high search activity, because of a high gap, a higher level of integration is achieved (innovative process). Similarly, when managers stay alert to new integrative opportunities but engage in low search activity, because of the low gap, a higher level of integration is also achieved (incremental process). Finally, it was shown

that lower level integration is achieved when managers are weakly alert (status quo process) even if they spend energy searching for opportunities (imitative process). The main contribution of this essay lies in its theoretical value to research on ERP integration, as it provides a new integrative framework of integration effectiveness that builds on complementary theoretical stances relevant to the involvement of managers in ERP implementation.

Essay #2

In the second essay, a measure of ERP integration at the module level as well as its impact on business process performance was developed. This framework was anchored on complementary theoretical stances relevant to integration and was composed of three dimensions: system, user, and business process integration. To validate the measure, a survey was developed and data were collected from firms that had implemented ERP modules. The results showed a 3-dimension construct for assessing ERP module integration. Additionally, the link between ERP module integration and business process performance was found to be positive. The essay contributes to the research on ERP integration, as it provides a new, complementary way to measure ERP integration at the module level.

Essay #3

In the third essay, an empirical test of antecedents and impacts of ERP module integration was developed. The model was tested using a cross-sectional web survey and information was gathered from 148 ERP module implementations. The results showed the relationships between: (1) integration process and ERP module integration, (2) perceived gap and integration process, (3) perceived gap and ERP module integration, and (4) ERP module integration and business process performance. More specifically, it was found that design, the second activity of the integration process, positively influenced the degree of ERP module integration while perceived gap negatively influences it. Furthermore, the role of perceived gap was limited to influencing design. The integration process was found to be composed of alertness influencing search and search influencing design. Finally, it was established that the higher the degree of ERP module

integration, the higher the performance of the business processes. This essay contributes to research and practice on the link between ERP and performance at the process level by looking at factors influencing the integration of an ERP module, which influences the performance of the business processes.

Contributions

Several interesting theoretical and managerial implications have emerged from the findings of this thesis. As a first step toward developing an understanding of the process to achieve integration, the decomposition of the process has enabled the understanding of how value is extracted from ERP investments and how organizations convert potential ERP investments into realized value. By developing a better understanding of the integration process through alertness, search, and design, an attempt to "look inside the black box" of ERP integration was provided. The decomposition of the integration process has also contributed to the resource-based view of literature, by defining specific activities necessary to achieve ERP integration.

Second, the review of the literature on integration provided a much needed measure of the construct in an ERP context at the module level. ERP integration has mostly been measured by the number of modules implemented (functional) and the number of sites or geographic reach of implementation (physical), limiting our understanding of the effect of integration. Empirical support for a theoretically sound conceptualization and operationalization of ERP integration at the module level was developed. The measure of ERP module integration complements research on integration, which tends to view integration as either the integration of the system alone, or with the business process, by identifying three important dimensions of integration. This will inform IS researchers that to measure different degrees of integration, three dimensions are to be considered. The measure developed in this thesis could also be used by other researchers for future research on various IT integration studies by considering the system, business process and user aspects of the integration.

Finally, this thesis provides contributions to IS research in general by framing a model that explains substantial performance variance through integration, for firms investing in a similar technology. The link between ERP integration and performance has received some attention; however, this thesis has provided a complementary perspective, which brings additional depth to research on ERP integration by positioning the phenomenon at the process and module levels and looking at different degrees of ERP module integration.

Practitioners might also benefit from the findings of this thesis by adapting their implementation methodologies to ensure the implications of managers in the ERP module for which they are responsible. The role of managers has been strongly emphasized in this thesis to ensure ERP integration, and subsequently the performance of the business processes. It has been demonstrated that managers' integration activities and perception of the gap can significantly contribute to the integration of an ERP module, and thus, the performance of their business processes. Top management and IS managers can adapt the way they manage ERP implementation projects by recognizing the role of managers in the implementation of an ERP and by promoting awareness to integrative opportunities.

Another important contribution of this research to practitioners is the quantitative appraisal of the different dimensions of ERP module integration on business process performance. Managers of ERP projects should put emphasis on developing not only the system and business process integration dimensions of an ERP, but also making sure that users understand the integrative nature of the ERP and how their actions may influence the work of others. By providing appropriate training to users of an ERP module about the integrative potentialities of the ERP, organizations are likely to reap the benefits of their systems.

Future Research

Although avenues for future research have been provided for in each essay, there are four important avenues for future research on ERP integration in general. First, this research focuses on the integration of ERP at the module level.

However, more research is needed to provide a firm level measure of integration based on the one proposed in this dissertation. It would be interesting to look at a measure of integration at the firm level based on the findings, i.e. the three dimensions of integration. Furthermore, more data could be collected from multiple ERP modules in the same organization to look at their impact on firm level integration. More specifically, by looking at the integration of each ERP module, a better understanding of why organizations implementing the same ERP modules have different results could be provided. Such a study should be performed using a survey.

Second, although the research model on ERP module integration has outlined the importance of the integration process through search, design, and alertness, there is evidence from the interviews conducted in the first essay that these activities need to be pursued throughout the life of the systems. However, much less is known about what managers do after the ERP system has gone live. Examples of research questions that could address this gap include the following: What is the role of managers after the ERP system has gone live? Do managers continue to identify and exploit integrative opportunities? Does the level of integration change over time? Those questions are examples of issues that would provide a more profound understanding of the role of managers in continuing to extract benefits from ERP systems through integration. Future studies could be done to gather data in real-time and longitudinally to answer those questions.

Third, in this dissertation, the assessment of antecedents was limited to one organizational context, perceived gap, and three managerial activities, namely alertness, search, and design of integrative opportunities. Even though a significant proportion of the variance in ERP module integration was explained (i.e. R^2 = 57%), more research is needed in order to evaluate the main impact of those activities on ERP integration. For example, are those activities performed the same way across the different types of ERP modules? Further, factors other than those proposed could potentially facilitate the integration of an ERP. For instance, high levels of top management support and ERP training have been shown to be important factors in successful ERP implementation. In sum, more

research should be conducted in order to identify other antecedents of ERP integration.

Given the strong influence of ERP module integration on performance (Essay #3), a final avenue for future research consists of identifying the integration ERP outside the organization with suppliers (Supply Chain Management systems) and clients (Customer Relationship Management systems) and its impact of various measures of performance. There is more research needed on the integration of other technologies with ERP such as CRM, SCM, and business intelligence (BI) systems. Additionally, given that the dependent variable was measured as the overall performance of the business processes, it would be valuable to have a better understanding of the impact of ERP module integration on a specific measure of performance. For instance, it would help provide an answer as to whether ERP module integration has the same influence on efficiency as on effectiveness of business processes. Indeed, previous research has looked at the role of ERP on various measures of business process performance such as effectiveness, flexibility, and efficiency (Karimi et al. 2007).

Concluding Remarks

This dissertation has been a great opportunity to generate some insights about key aspects of ERP integration at the module level, i.e. its measurement, antecedents, and consequences. The main premise of this dissertation is that performance difference among firms investing in the same technology can be attributed to the way the technology is integrated to the technological infrastructure and business processes. A specific technology was studied, the ERP, and it was found that different degrees of an ERP module exist, which influence the performance of the business process. Finally, to achieve such integration, it was established that managers have a key role: to identify and exploit integrative opportunities, which depends on the gap perceived between the actual way of working and the business processes provided by the ERP module.

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Appendix 1: Questionnaire

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1. ERP implementation

*** 1. Have you been involved in an ERP implementation as a managers? For instance, Mr.Doe, Director of Financial Systems and Treasury was involved in the implementation of the ERP system at his company, more specifically, the finance module.**

- ◯ Yes
- ◯ No

2. Thank you

Thank you for your interest in our study but you are not the respondent we are looking for.

1. If you know other managers that could benefit from this study, please advise us and we will email him/her an invitation to participate in our study.

Name: _____

Email: _____

3. Part I: ERP Module project

PART 1 - ERP Module Project
The following questions refer to the **latest ERP module** implementation for which you were directly involved. We are interested in business managers' point of view.

1. Please indicate the ERP module/adds-on for which you were involved the most. If you were involved in multiple modules or adds-on implementation, please <u>choose the one</u> you were the most involved with.

- ◯ Administration module
- ◯ APS Advanced Planning Systems
- ◯ AS Application Server
- ◯ AM Asset Management
- ◯ CRM Customer Relationship Management
- ◯ DW Data Warehouse
- ◯ EDI Electronic Data Interchange
- ◯ EAI Enterprise Application Integration
- ◯ FI Financials
- ◯ HR Human Resources
- ◯ Industry specific adds-on
- ◯ Inventory module
- ◯ MM Material Management
- ◯ MRP module
- ◯ PMI Portal Mobile Infrastructure
- ◯ PLM Product Lifecycle Management
- ◯ PP Production Planning
- ◯ PS Project System
- ◯ Purchasing Module
- ◯ QM Quality Management
- ◯ SD Sales & Distribution
- ◯ SP Strategic Planning
- ◯ SRM Supplier Relationship Management
- ◯ SCM Supply Chain Management

Other (please specify)

_____

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2. Which ERP package vendor was chosen for this module?

◯ JD Edwards ◯ PeopleSoft ◯ Don't know

◯ Oracle ◯ SAP

Other (please specify)

3. What was the budget for the implementation of this ERP module?

4. When the project to implement the ERP module started? (MM/YYYY)

5. When the ERP module went live? (MM/YYYY)

6. What was your role during the implementation of the ERP module?

☐ Project manager ☐ Integrator ☐ Super user

☐ Business analyst ☐ Knowledge worker

Other (please specify)

7. How many people were involved in the implementation of the ERP module?

8. How many people are using this ERP module?

9. Did you use an implementation partner?

◯ Yes ◯ No ◯ Don't know

If so, please specify his/her role (integrator, consultant, etc.)

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10. Were they any ERP modules and/or adds-on in used before the implementation of this module, if so please specify.

- [ ] Administration module
- [ ] APS Advanced Planning Systems
- [ ] AS Application Server
- [ ] AM Asset Management
- [ ] CRM Customer Relationship Management
- [ ] DW Data Warehouse
- [ ] EDI Electronic Data Interchange
- [ ] EAI Enterprise Application Integration
- [ ] FI Financials
- [ ] HR Human Resources
- [ ] Industry specific adds-on
- [ ] Inventory module
- [ ] MM Material Management
- [ ] MRP module
- [ ] PMI Portal Mobile Infrastructure
- [ ] PLM Product Lifecycle Management
- [ ] PP Production Planning
- [ ] PS Project System
- [ ] Purchasing Module
- [ ] QM Quality Management
- [ ] SD Sales & Distribution
- [ ] SP Strategic Planning
- [ ] SRM Supplier Relationship Management
- [ ] SCM Supply Chain Management
- [ ] Don't know
- [ ] None

Other (please specify)

11. How many other ERP modules and adds-on were implemented together with this module in your company?

	Number
ERP modules	
Adds-on	

Other (please specify)

The following questions refer to the ERP system implemented for the entire company.

12. How many people (internal)were involved in the implementation of the ERP system ?

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13. Which of the following statements best reflect the current ERP system in your company?

- ◯ It is installed in only my department
- ◯ It is installed in all departments of my organization
- ◯ It is installed in multiple sites in one region or state
- ◯ It is installed in multiple sites in multiple region or states
- ◯ It is installed in multiple sites internationally
- ◯ Don't know

Other (please specify)

14. How many people are using the ERP system in your company?

4. Part II: The specific ERP module

In this section, you will be asked questions about the ERP module for which you were involved. If more than one module was implemented, **please refer to the one that you were the most involved with**. If some questions may not be applicable to your module, please answer NA.

The following questions refer to the **fit** between the ERP module and your current business processes, user intefaces, and data. Please indicate the extent to which you agree/disagree with the following statements.

1. Business process fit.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The processes built in the ERP module meet all needs required from organizational processes.	◯	◯	◯	◯	◯	◯
2. The processes flow built in the ERP module correspond to flow of organizational processes.	◯	◯	◯	◯	◯	◯
3. The processes built in the ERP module accommodate the change required from organizational processes.	◯	◯	◯	◯	◯	◯
4. The processes built in the ERP module correspond to the business practices of our business unit.	◯	◯	◯	◯	◯	◯

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2. Data fit.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The name and meaning of the ERP module data items correspond to those of the documents used in our business unit(i.e. a sales order sheet, sales report).	◯	◯	◯	◯	◯	◯
2. The form and format data items of the ERP module correspond to those of the documents used in our business unit.	◯	◯	◯	◯	◯	◯
3. The output data items of the ERP module correspond to those of the documents used in our business unit.	◯	◯	◯	◯	◯	◯
4. The input data items of the ERP module correspond to those of the documents used in our business unit.	◯	◯	◯	◯	◯	◯

3. User Interface fit.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. User interface structures of the ERP module are well designed to the work structure required for conducting business in our business unit.	◯	◯	◯	◯	◯	◯
2. User interface of the ERP module is well designed to the user capabilities of our business unit.	◯	◯	◯	◯	◯	◯
3. User interface of the ERP module is well designed to the business needs of our business unit.	◯	◯	◯	◯	◯	◯

4. Overall Fit

	%
What percentage of your business processes did not fit the ones provided by the ERP module?	
What percentage of the ERP module was customized?	

The following questions refer to the **integration** achieved with your ERP module. Please indicate the extent to which you agree/disagree with the following statements.

5. Data integration.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The ERP module provides high level of enterprisewide data integration.	◯	◯	◯	◯	◯	◯
2. The ERP module allows us an integrated access to all data.	◯	◯	◯	◯	◯	◯
3. Same data stored in different databases across the ERP module are consistent.	◯	◯	◯	◯	◯	◯
4. Data can be shared easily among various ERP modules.	◯	◯	◯	◯	◯	◯
5. Definitions of key data elements are common across the ERP modules.	◯	◯	◯	◯	◯	◯

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6. Application integration.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The ERP module is integrated with other modules.	◯	◯	◯	◯	◯	◯
2. The ERP module is integrated with other systems and IT applications.	◯	◯	◯	◯	◯	◯
3. The ERP module functions as an integrated system.	◯	◯	◯	◯	◯	◯
4. The ERP module communicates in real time with other modules.	◯	◯	◯	◯	◯	◯

7. System integration.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The ERP module is integrated with the various IT applications in your unit.	◯	◯	◯	◯	◯	◯
2.The ERP module with other IT applications, has been combined into a functional whole or a unified system.	◯	◯	◯	◯	◯	◯

8. Business process integration.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The business processes are well integrated with one another.	◯	◯	◯	◯	◯	◯
2. The activities of our business processes are closely coordinated.	◯	◯	◯	◯	◯	◯
3. The activities of our business processes are integrated within our department.	◯	◯	◯	◯	◯	◯
4. The activities of our business processes are integrated with the business processes of other departments.	◯	◯	◯	◯	◯	◯
5. Our business processes are standardized for information exchange with other departments.	◯	◯	◯	◯	◯	◯

9. Cognitive integration.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The users of the ERP module are aware of the integrative nature of the module in their department.	◯	◯	◯	◯	◯	◯
2. The users of the ERP module are aware that the different modules and business processes are tightly coupled.	◯	◯	◯	◯	◯	◯
3. The users of the ERP module are aware of the integrative nature of the cross-functional business processes.	◯	◯	◯	◯	◯	◯
4. The users of the ERP module are aware of the integrative nature of the other modules in their company.	◯	◯	◯	◯	◯	◯

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10. Behavorial integration.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The users of the ERP module understand how their work activities (entering new data, modifying data, deleting data, etc.) impact the work of other ERP users.	◯	◯	◯	◯	◯	◯
2. The users of the ERP module understand how their work activities (entering new data, modifying data, deleting data, etc.) impact the business processes of the department.	◯	◯	◯	◯	◯	◯
3. The users of the ERP module understand how their work activities (entering new data, modifying data, deleting data, etc.) support the goals of the other modules.	◯	◯	◯	◯	◯	◯
4. The users of the ERP module understand how their work activities (entering new data, modifying data, deleting data, etc.) impact the operations of business processes of other functional areas.	◯	◯	◯	◯	◯	◯

11. User integration.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The users of the ERP module have similar understandings of its functioning and integrative nature.	◯	◯	◯	◯	◯	◯
2. The users of the ERP module understand the impact that their usage can have on the work of other users of the module.	◯	◯	◯	◯	◯	◯

12. ERP Module Integration

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The ERP module, its users and business processes are well integrated.	◯	◯	◯	◯	◯	◯
2. This ERP module is well integrated with other relevant IT applications and business processes.	◯	◯	◯	◯	◯	◯

13. ERP system integration

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. All the ERP modules in the company are well integrated together.	◯	◯	◯	◯	◯
2. All the ERP modules are well integrated with other IT applications in the company.	◯	◯	◯	◯	◯

5. Part III: Attitude, capacity, and actions

In this section, you will be asked about attitudes, capacities, and actions of the managers involved in the implementation of the ERP module. Please indicate the extent to which you agree/disagree with the following statements.

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1. Adapting the system.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The business processes in our unit were modified.	◯	◯	◯	◯	◯
2. Additional developments for the ERP module were needed.	◯	◯	◯	◯	◯
3. The IT experts/consultants needed to develop alternative solutions to reduce the gap between the current business processes and the new business processes supported by the ERP module.	◯	◯	◯	◯	◯
4. The ERP module was altered to improve its fit with this plant.	◯	◯	◯	◯	◯
5. When the ERP module was being implemented in this business unit, the package was changed to better meet the needs of this plant.	◯	◯	◯	◯	◯

2. Searching for a solution. The managers involved in the implementation of the ERP module...

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. read publications about how other divisions/companies have implemented a similar module.	◯	◯	◯	◯	◯
2. searched for ways to improve the business processes of the ERP module.	◯	◯	◯	◯	◯
3. talked to others in their divisions about how their work processes or tasks are different in the module.	◯	◯	◯	◯	◯
4. searched for ways to do things with the module that no one else seemed to know about.	◯	◯	◯	◯	◯
5. looked at what other divisions/organizations were doing with the same module.	◯	◯	◯	◯	◯

3. Awareness to new opportunities. The managers involved in the implementation of the module...

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. were attentive to the unique needs of their unit and what opportunities the ERP module could offer them.	◯	◯	◯	◯	◯
2. were on the alert for new opportunities with the module.	◯	◯	◯	◯	◯
3. felt the need to be alert at all times to new possibilities with the module.	◯	◯	◯	◯	◯
4. were prepared to think about counterintuitive opportunities with the module.	◯	◯	◯	◯	◯
5. were aware of new ways of doing the same work with the new module.	◯	◯	◯	◯	◯

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4. State of mind. The managers involved in the implementation of the ERP module...

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. like to investigate things.	◯	◯	◯	◯	◯
2. are always open to new ways of doing things.	◯	◯	◯	◯	◯
3. get involve in almost everything they do.	◯	◯	◯	◯	◯
4. are curious.	◯	◯	◯	◯	◯
5. generate novel ideas.	◯	◯	◯	◯	◯
6. make novel contributions.	◯	◯	◯	◯	◯
7. are creative.	◯	◯	◯	◯	◯
8. find ways to create new and effective ideas.	◯	◯	◯	◯	◯
9. can behave in many different ways for a given situation.	◯	◯	◯	◯	◯
10. attend to the big picture.	◯	◯	◯	◯	◯
11. notice what other people are up to.	◯	◯	◯	◯	◯
12. are aware of changes.	◯	◯	◯	◯	◯
13. are aware of new developments.	◯	◯	◯	◯	◯

5. Top management support.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Senior executives demonstrated a lot of enthusiasm and interest throughout the project.	◯	◯	◯	◯	◯
2. The overall level of management support in this project was high.	◯	◯	◯	◯	◯
3. Upper-level managers were personally involved in the project.	◯	◯	◯	◯	◯
4. The senior management believed that the ERP project had the potential to provide significant business benefits to the firm.	◯	◯	◯	◯	◯
5. The senior management believed that ERP will create a significant competitive arena for firms.	◯	◯	◯	◯	◯

6. Training.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Time and resources were invested in training employees on using the new module.	◯	◯	◯	◯	◯
2. Adequate on-the-job training was provided to internal user groups to use the new module.	◯	◯	◯	◯	◯
3. Both technology and process training were provided to employees using the module.	◯	◯	◯	◯	◯
4. Our company provided ERP training opportunities on a regular basis.	◯	◯	◯	◯	◯
5.Our company provided adequate technical support to using the ERP module.	◯	◯	◯	◯	◯

6. Part V: Business Impact of ERP

In this section, you will be asked to assess the **present** performance of you business processes compared to their

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performance before the implementation of the ERP module. Please indicate the extent to which you agree/disagree with the following statements.

1. Business process efficiency.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The efficiency of our business processes is high.	◯	◯	◯	◯	◯	◯
2. The amount of rework needed because of data entry errors is low.	◯	◯	◯	◯	◯	◯
3. The productivity of the staff is high.	◯	◯	◯	◯	◯	◯
4. The cost of our operations is low.	◯	◯	◯	◯	◯	◯

2. Business process flexibility.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The flexibility of our processes is high.	◯	◯	◯	◯	◯	◯
2. The flexibility of our operations is high.	◯	◯	◯	◯	◯	◯
3. The possibility of achieving rapid changes to our operations is high .	◯	◯	◯	◯	◯	◯
4. The possibility of customizing of our processes is high.	◯	◯	◯	◯	◯	◯

3. Business process effectiveness.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The value of the data provided to manage our operations is high.	◯	◯	◯	◯	◯	◯
2. The quality of our operations is high.	◯	◯	◯	◯	◯	◯
3. The satisfaction of our internal and external clients is high.	◯	◯	◯	◯	◯	◯
4. The quality of our forecasts is high.	◯	◯	◯	◯	◯	◯

4. Business process performance

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
1. The overall business process performance is high.	◯	◯	◯	◯	◯	◯
2. The operation of our business processes is high.	◯	◯	◯	◯	◯	◯

Please indicate the extent to which you agree/disagree with the following statements regarding the success of the implementation of the module.

5. ERP module implementation Success

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't know
1. The implementation of the ERP module was completed on time.	◯	◯	◯	◯	◯	◯
2. The implementation of the ERP module was completed on budget.	◯	◯	◯	◯	◯	◯
3. The implementation of the ERP module was completed within original scope.	◯	◯	◯	◯	◯	◯
4. The users are satisfied with the new ERP module.	◯	◯	◯	◯	◯	◯

In this section, you will be asked to assess the overall impact of the ERP system on your firm and the turbulence of your firm's environment.

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6. Impact of ERP system on your company.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Don't know
1. The ERP system has improved the company's overall business performance.	◯	◯	◯	◯	◯	◯
2. In terms of its business impacts on the company, the ERP system has been a success.	◯	◯	◯	◯	◯	◯
3. The company has realized significant measurable financial benefits from the ERP system.	◯	◯	◯	◯	◯	◯
5. The company is more competitive as a result of the ERP system.	◯	◯	◯	◯	◯	◯
6. Overall, users are satisfied with the ERP system.	◯	◯	◯	◯	◯	◯

7. Part VI: Demographics

These questions are required to analyze the survey results in the context of the firm size and the respondent's job function.

1. Select your company's primary industry.

◯ Chemical & Pharmaceutical
◯ Manufacturing & Processing
◯ Computer
◯ Medical
◯ Consultants
◯ Petroleum
◯ Education
◯ Trade
◯ Finance
◯ Transportation Services
◯ Government
◯ Utilities
◯ Legal
◯ Don't know

Other (please specify)

2. How many employees are there in your company? In your busines unit?

Company:

Business unit:

3. What is your current job title?

◯ Functional management (Systems analyst/Scheduler/Planner)
◯ Department/Division managers (Director/Operations manager)
◯ Senior Management (CEO/VP/General manager)

Other (please specify)

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4. What is you gender?

- ◯ Female
- ◯ Male

5. Experience

How long have you worked in this company?

How long have you been in this position?

How many times have you been involved in an ERP implementation?

How many past ERP projects you were involved in were successes?

6. Did you have knowledge about ERP prior to this implementation?

- ◯ Yes
- ◯ no

Other (please specify)

7. What is your age?

- ◯ 20-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60+

8. What is the highest degree you received?

- ◯ High school degree
- ◯ Collegial/technical degree
- ◯ Bachelor degree
- ◯ Master degree
- ◯ PhD degree

Other (please specify)

9. In what area have you received most of your education?

- ◯ Art
- ◯ Business
- ◯ Humanities
- ◯ Engineering
- ◯ IS/IT
- ◯ Law
- ◯ Social sciences
- ◯ Sciences (biology, chemistry, physics, etc.)
- ◯ Other

If business, please specify (finance, marketing, etc.)

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10. For statistical purposes, it is necessary to keep track of the number of responses received from each firm so they can be aggregated as a single unit for the data analysis.

Company:

Business Unit:

11. Thank you for your participation. A managerial report, based on this study, will be available for those participants that wish to receive it.

Name:

Email address: