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Risks, Controls and Business Value of IT-Enabled Interfirm and Intrafirm Processes

Chaitanya Sambhara

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RISKS, CONTROLS AND BUSINESS VALUE OF IT-ENABLED INTERFIRM AND INTRAFIRM PROCESSES

BY

CHAITANYA KRISHNA SAMBHARA

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

Of

Doctor of Philosophy

In the Robinson College of Business

Of

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CENTER FOR PROCESS INNOVATION
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2015

ACCEPTANCE

This dissertation was prepared under the direction of the *Chaitanya Krishna Sambhara's* Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

Richard Phillips, Dean

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ABSTRACT

RISKS, CONTROLS AND BUSINESS VALUE OF IT-ENABLED INTERFIRM AND INTRAFIRM PROCESSES

BY

Chaitanya Krishna Sambhara

7/12/2015

Committee Chair: *Dr. Arun Rai*

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There have been significant advances in the information systems (IS) literature about the business value that can be realized through information technology (IT) investments and the mechanisms through which IT creates different facets of business value. We identify three important gaps in understanding the literature on IT business value. First, it is unclear how risk arising from deficiencies in a firm's information environment, along with internal and external contextual factors, affects a firm's IT implementation choices. Second, it is unclear how IT resources in a focal domain need to be combined with knowledge resources in the same domain and IT resources in other domains to develop process capabilities and create process-level benefits. Third, it is unclear what risks IT-enabled process innovations create for different process stakeholders and what controls can be applied to mitigate these risks.

My dissertation addresses the above three gaps in three essays. The first essay examines the influence of a firm's information risk on its prioritization of accounting enterprise systems (AES) relative to complementary enterprise systems and the moderation of this relationship by the weaknesses of internal controls and environmental uncertainty characteristics. The second essay focuses on the impact of AES implementation on a firm's internal controls process, and the complementary roles of managerial competence and enterprise systems implemented in other domains related to the internal controls process of the firm. The final essay explores the risk factors that can arise for buyers and suppliers due to the use of reverse auctions, and the controls that can be applied to mitigate the key risk factors. In terms of research methods, the first two essays apply econometric analysis to panel datasets constructed from multiple sources and the third essay uses a combination of Delphi studies and semi-structured interviews.

Collectively, the essays advance our understanding of (1) the factors underlying a firm's prioritization of IT investment choices; (2) the mechanisms through which IT resources, in combination with human expertise, create business value; and (3) the risks introduced for different stakeholders by the adoption of IT-enabled process innovations and the controls that can be used to effectively mitigate them.

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"Certainly, there is no purifier equivalent to knowledge" Bhagawad Gita **4:38**

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1 Table of Contents

1. Chapter 1— Introduction

Information Technology (IT) investments come at high cost and contribute significantly more than non-IT investments to firm risk, which is defined as variability of return on investments (Dewan et al. 2007b). In fact, the old "productivity paradox" (Brynjolfsson et al. 1993; Carr 2003) is abetted by studies identifying risks associated with IT project and information system (IS) implementation failures that result in the loss of billions of dollars (e.g., Doms 2004; Keil et al. 2000). On the one hand, firms that underinvest in IT face the risk of inefficient processes, low productivity, and deficient competitiveness (Bharadwaj 2000). On the other hand, IT investments can lead to the risk of failed implementations, underutilized and ineffective IS, and loss of capital.

While past studies have expanded our understanding about risks and risk mitigation strategies associated with IT initiatives (Benaroch 2002; Persson et al. 2009), there is inadequate understanding about risks, controls, and IT initiatives on three fronts. First, while deficiencies in cross-functional business processes introduce various firm-level risks, the influence of these risks on IS implementation choices have not been examined. Second, while our understanding of how business process capabilities can be developed from IT resources and capabilities has expanded (e.g., Rai et al. 2006; Rai et al. 2010), it is unknown how business processes, which differ in objectives and nature of activities, are impacted by IT resources and how business processes, in turn, affect process performance. Third, although the role of IT in enabling innovative business models and interfirm business processes has been explored (Rai et al. 2014), it is unclear how IT-enabled innovation of interfirm business processes creates risks for different stakeholders and how controls can be designed to mitigate these risks.

My dissertation addresses the above three gaps in three essays. The essays draw on complementary literatures in IS and firm strategy, operations, and accounting and use both quantitative and qualitative methods. The first essay focuses on a key firm-level risk (i.e., information risk) that arises due to poor coordination of financial reporting activities across several functional domains (e.g., supply chain, customer relationship). It examines how information risk drives the prioritization of enterprise systems in the accounting domain, or accounting enterprise systems (AES), relative to enterprise systems (ES) in other business domains (e.g., supply chains, customer relationship), or complementary enterprise systems (CES). It also examines how the

relationship between information risk and the prioritization of AES over CES is affected by a firm's internal controls and by environmental factors. The second essay evaluates how the IS implemented to coordinate activities in a functional domain (i.e., AES implemented to coordinate activities in the accounting domain) enables the development of process capabilities to address risks (i.e., internal controls) and improve process performance. The third essay identifies the intrafirm and interfirm risks that arise prior to, during, and after the use of an IS, specifically reverse auctions, that are implemented to coordinate activities in the interfirm sourcing process. Table 1.1 summarizes the goal of each essay, theoretical perspectives used, scope, data sources, methodology used, and the data summary. An overview of each of the essays is discussed below.

1.1 Essay 1

The first essay examines how information risk drives the prioritization of enterprise system implementations, specifically AES vs. CES implementations, and how this relationship changes due to weaknesses in internal controls and by environmental uncertainty. The essay is informed by resource based theory and the economic theory of complementarities, and by the literatures on information risk, internal controls, and ES implementations.

Information risk refers to the likelihood that information provided by a firm pertinent to investor pricing decisions is of poor quality. It is an important factor that determines the rate of return premium demanded by investors (Francis et al. 2005; Gray et al. 2009). It is important for firms to reduce information risk to avoid paying high premiums to their stakeholders (including investors and business partners). Despite the important role played by information risk in affecting a firm's financial performance, the role of information risk in affecting a firm's IT implementation choices has not received much attention.

This essay evaluates how firms prioritize IT-enabled process capabilities in specific domains and IT-enabled process capabilities in other complementary domains when faced with information risk. On one hand, a firm can implement AES to improve their internal controls. On the other hand, a firm can implement CES to improve activities in other business domains and the overall information environment of the firm. Information risk is hypothesized to influence the prioritization of AES vs. CES implementations, and internal controls and

environmental uncertainty are hypothesized to moderate the relationship between information risk and the prioritization of AES vs. CES implementations.

Rigorous econometric analyses were conducted on a panel data set that was constructed for 883 firms for the period 2004 to 2008. The findings contribute to our understanding on how information risk, internal controls, and environmental uncertainty affect the prioritization of AES vs. CES implementations.

1.2 Essay 2

Essay 2 builds on essay 1 by examining how AES implementations, together with complementary managerial and technological resources, affect the capability of internal control processes and process performance.

Although prior studies have demonstrated the mediating role of business process capabilities in the IT-business value causal chain (e.g., Melville et al. 2004, Ray et al. 2004, Kohli and Grover 2008, Rai and Tang 2010), the complementary roles of domain-specific competence and related IS capabilities are not clear. Drawing on resource-based theory and theory of complementarities, this study identifies AES as a critical IT resource to improve internal control processes and examines how (a) CES complements AES in improving internal control processes and audit process performance, (b) accounting managerial competence complements AES in improving internal control processes and audit process performance, and (c) improvements in internal control processes affect audit process performance.

Rigorous econometric and multivariate analysis was conducted on an archival panel data set constructed for 314 firms for the period 2004 to 2009. This essay contributes to our understanding of the ways IT-enabled process capabilities can be developed and of the resulting process-level business value.

1.3 Essay 3

The third essay examines how the adoption, implementation, and use of IT can change intrafirm and interfirm relationships, and introduce novel risks that call for novel controls. Specifically, this study shows how the use of internet enabled reverse auctions (RAs) can induce risks for buyers and suppliers, and identifies several controls that can effectively address the risks.

Prior studies that have examined RAs have primarily researched the buyer perspective and have largely focused on (a) the ability of RAs to reduce procurement costs (Jap 2002; Jap 2003; Jap et al. 2002), (b) effective design configuration techniques for RAs (Mithas et al. 2007), (c) factors that determine buyers' intentions to use RAs (Hartley et al. 2004; Mithas et al. 2008), and (d) the impact of RAs on buyer-supplier relationships (Daly et al. 2005; Jap 2007). Though studies acknowledge that even successful adoption, implementation, and use of RAs can induce risks (Giampetro et al. 2007; Smeltzer et al. 2003) , a concentrated effort to identify them has not been undertaken.

Using a qualitative Delphi study, risk factors from both the buyer and supplier perspectives were identified. Follow-up semi-structured interviews revealed that input controls are especially important in addressing key risk factors. An interpretation of the risk factors reveals that the risks span intangible resources, auction process governance, and factors identified in classical theories of governance (i.e., agency, transaction cost, and relational). Interestingly, two factors not suggested by classical theories of interfirm governance – reverse information asymmetry (where the buyer has greater information than the supplier) and principal opportunism – surfaced as two risk factors, both of which are detrimental to suppliers and can occur due to the use of reverse auctions. The set of control actions discovered through the follow-up semi-structured interviews provide a basis for firms to mitigate salient risks and effectively utilize RAs.

Table 1.1. Summary of Essays

Essay	Goal of the Essay	Theoretical Perspectives	Scope	Data Sources	Methodology	Data Summary
1	Examine the impact of information risk on a firm's prioritization of AES vs. CES implementations and the role of internal controls and environmental uncertainty in moderating this influence.	Resource-based theory Theory of complementarities	Intrafirm	• Audit Analytics • Compustat • Computer Intelligence Database	• Econometric Analysis • Multivariate Analysis	2604 firm-year observations for 883 firms in the 2004 to 2008 period
2	Examine how AES use impacts the capability of internal control processes, and the impact of the capability of internal control processes on audit process performance. Also examine how the impact of AES on the capability of internal control processes is complemented by CES and accounting managerial competence.	Resource-based theory Theory of complementarities	Intrafirm			1481 firm-year observations for 314 firms in the 2004 to 2009 period
3	Examine buyer and supplier risk factors associated with RA use, and the controls that can be applied to mitigate risk factors.	Agency theory Relational theory Transaction cost theory	Intrafirm and Interfirm	• Institute of Supply Management	• Qualitative Delphi Study • Semi-Structured Interviews	• 28 buyers and 31 suppliers for Delphi Study • 7 buyers and 7 suppliers for semi-structured interviews

2 Chapter 2 — Prioritizing Enterprise System Implementations: Role of Information Risk, Internal Controls and Environmental Uncertainty

2.1 Abstract

We examine the influence of information risk on the prioritization of enterprise system (ES) implementation by firms and the role of internal controls and environmental uncertainty (EU) in changing the nature of this influence. Specifically, we study how increasing information risk faced by firms affects the prioritization in the implementation of accounting enterprise systems (AES) and other enterprise systems, which we refer to as Complementary Enterprise Systems (CES).

We construct a multi-source firm-level panel dataset with a sample of 883 firms from 2004 to 2008 and use econometric and multivariate analysis procedures to test our hypotheses. Our results suggest that with an increase in information risk, firms (a) prioritize implementation of AES over CES when faced with weak internal controls, and (b) prioritize implementation of CES over AES when operating in highly complex and dynamic industry environments. We do not find evidence that firms prioritize implementation of either AES or CES when operating in highly munificent environments. The results expand our understanding of how a firm's IS resource allocation to AES and CES is influenced by information risk and how internal and a firm's external environments affect resource allocation to enterprise systems under different conditions.

Keywords: Information Risk, Internal Controls, Environmental Uncertainty, Enterprise System Implementation

2.2 Introduction

Information risk is the likelihood that a firm's financial information that is pertinent to investor pricing decisions is of poor quality (Francis et al. 2005). A firm is said to have high information risk when its investors lack information or have insufficient information as compared to other stakeholders (i.e., insiders within a firm and other investors) regarding the accuracy of its earnings. The higher the information risk, the less informed are investors. Information risk can result in a lack of investor confidence in a firm's financial health, investor demands for higher rate of return premiums, and increased cost of capital (Francis et al. 2005; Gray et al. 2009).

It is particularly difficult for firms operating in uncertain environments to address information risk. Increasing uncertainty of the operating environment makes firms more prone to information risk since (a) it is more difficult to coordinate business units and functional domains when operating uncertainty is high, and (b) high operating uncertainty increases transaction costs, the likelihood of incurring losses, and incurring drops in market capitalization (Barua et al. 2004; Doyle et al. 2007b; Srinivasan et al. 2002).

Research has shown that firms address financial and operational risks and optimize their operations in uncertain environments by implementing and using ES, which are typically large, complex, and expensive information systems (IS) (Grabski et al. 2011; Ko et al. 2005). Studies have also shown that ES assist firms in reducing coordination and transaction costs, improve information processing capabilities, and reduce supply, demand and quality uncertainties (Dorantes et al. 2013; Gattiker et al. 2005; Ranganathan et al. 2006).

While it is known that implementing and using ES assists firms in addressing operational risks in complex and uncertain operating environments, it is not clear how firms' ES implementation decisions vary according to the nature and the extent of encountered risks. Do firms implement ES differently when faced with high level of information risk? Given the high cost and complexity of implementing them, how do firms balance the implementation of different ES? This study seeks to answer these questions by examining the impact of information risk in driving firms' ES implementation decisions. Specifically, we examine how firms prioritize the implementation of AES and CES (CES collectively refers to Human

Resources (HR), Customer Relationship (CRM), Supply Chain (SC) and any other ES) (Davenport 1998; Ranganathan et al. 2006) when faced with information risk. We seek to uncover the conditions under which firms prioritize AES implementations over CES implementations and vice versa.

Although information risk is contingent upon firms' IS capabilities, it has been examined extensively in the domains of accounting and finance, but has been understudied in the IS literature. To elaborate, information risk is a function of a firm's ability to effectively perform the following two activities core to financial reporting: (a) accurately record and process financial data in a timely fashion, and (b) coordinate the financial information across business units and functional domains, and collectively report it at the firm level in its financial statements (Francis et al. 2005).

The IS capabilities required to perform both these activities are best provided by AES with critical support from CES (InvestopediaReport 2009)[1]. Complementary enterprise systems can support AES by enabling a value-chain framework that involves information processing tasks. Each ES within CES performs tasks for the processes that it supports. Each such task encompasses the mobilization, tabulation, and transmission of data necessary to conduct that process (Barki et al. 2005; Davenport 1998; Gattiker et al. 2005). Accounting enterprise systems coordinate the data across functional domains and business units. Accounting enterprise systems integrate accounting, finance and IT operations, segregate duties of personnel across business functions to prevent inappropriate access to data, and improve the internal information environment by providing fast reporting and analytic capabilities.

Accounting enterprise systems have gained immense popularity over the years. Strict regulatory laws that pressed for increased transparency compelled firms to reduce information risk, to which they responded with large-scale AES implementations. Indeed the largest share of the regulatory expenditure on the Sarbanes-Oxley Act of 2002 (SOX) compliance was spent on AES (InvestopediaReport 2009; Kallunki et al. 2011; Zrimesk et al. 2003)[2]. The key objective of SOX is to protect investors' interests. Sarbanes-Oxley mandates firms to (a) establish and maintain strong internal controls over financial reporting, and (b) test and publicly disclose the quality of the internal controls. Strong internal controls

[1] http://www.emrisk.com/services/regulatory-compliance
[2] See http://www.emrisk.com/services/regulatory-compliance

provide assurance to investors that the financial information provided by a firm is of good quality and the issued financial statements can be relied upon. Access to the information about the true quality of a firm's finances was otherwise privy only to the firms' management and auditors. Accounting enterprise systems facilitate compliance with SOX by digitizing internal controls processes, strengthening internal controls, and improving the information environment pertaining to firm finances.

A firm's internal controls reflect its ability to accurately collect, assess, and represent its earnings, expenditures, assets and liabilities in its financial statements. The internal controls can therefore also influence information risk. It is, however, not clear to what extent firms prioritize implementation of AES over CES when faced with high information risk and weak internal controls. This leads to our first research objective:

> ***RO1:*** *Examine how weakness in internal controls changes the influence of a firm's information risk on its prioritization of AES implementation versus CES implementation.*

The higher the EU, the more difficult it is for firms to consolidate and accurately report earnings and expenditures in their financial statements. Environmental uncertainty (EU) also makes it difficult for firms to coordinate and synchronize their supply chains, human resources, customer relationships and other operations (Eisenhardt 1989a; Flynn et al. 1999). Thus, unlike internal controls, higher EU may not warrant focused attention on AES. However, EU has multiple factors, such as complexity, dynamism, and munificence. Higher levels in each of these EU factors can warrant a different strategy for ES implementations. As such, it is not known to what extent firms prioritize AES and CES implementations when both EU and information risk are high. This leads to our second research objective:

> ***RO2:*** *Examine how EU changes the influence of information risk on a firm's prioritization of AES implementation over CES implementation.*

2.3 Background and Research Gap

We use two perspectives, the resource-based theory and the theory of complementarities, to evaluate how firms prioritize between AES and CES implementations when faced with information risk. Drawing on the resource-based theory, we identify ES as key IS resources that are implemented to address information risk, and examine how firms prioritize AES and CES implementations with

increasing information risk. Drawing on the theory of complementarities, we examine how weak internal controls and EU change the influence of information risk's impact on the prioritization of AES versus CES implementations.

Prior research that has drawn on the resource-based theory has developed our understanding of how IT resources generate business value for firms. Early research that examined the impact of IT resources found that firms that invest in IT resources achieve higher organizational productivity (Hitt et al. 1996), higher organizational efficiency (Rai et al. 1997b), and improved market valuation and financial performance (Bharadwaj 2000; Bharadwaj et al. 1999). Research in following years (Figure 2.1) focused on examining (a) how transaction characteristics, governance practices, and environmental conditions moderate the impact of IT resources on firm performance and risk (e.g., Dewan et al. 2007a; Dewan et al. 2011) , and (b) how IT resources in conjunction with other resources and capabilities improve firm performance through mediating processes as elaborated below.

For example, Barua et al. (2004) show how supplier-side and customer-side online information capabilities mediate the impact of system integrations on firms financial performance. Rai et al. (2006) evaluate how cross-functional IT integration capabilities lead to higher supply-chain process integration capabilities and improved firm performance. Rai and Tang (2010) examine how process capabilities mediate the impact of IT capabilities on improving a firm's competitive performance.

Several of these studies (e.g., Rai et al. 2006; Ray et al. 2005) demonstrate the utility of distinguishing between different IT resources and capabilities to understand how organizational capabilities are developed. Although the ways in which varied IT resources can be leveraged has been examined in past work, it is unclear how firms determine which IT resources to prioritize for development. We address this gap by evaluating how business needs, conditioned on internal and external contingencies, can drive the prioritization of IT resource allocation. Specifically, we examine how information risk, conditioned by weak internal controls and EU, influences the prioritization of AES and CES implementations.

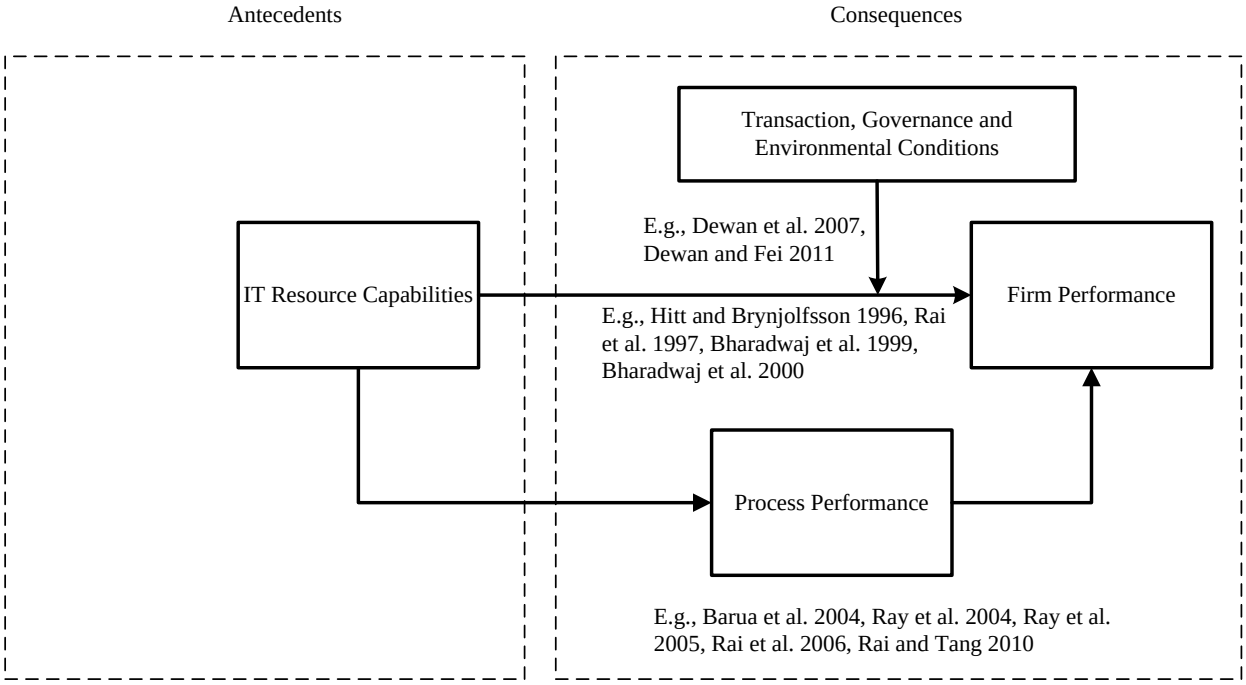


Figure 2.1. Information Systems Literature on Business Value and Resource-Based Theory

2.4 Research Model and Hypothesis Development

Figure 2.2 presents our research model and hypotheses. We now proceed to develop the logic for our research model and the hypotheses in the following sequence: (1) elaborate the concept of information risk, (2) develop the logic for the influence of information risk on the prioritization of AES implementation vs CES implementation, (3) theorize how internal controls moderate the influence of information risk on the prioritization of AES implementation vs CES implementation, and (4) theorize how EU moderates the influence of information risk on the prioritization of AES implementation vs. CES implementation.

2.4.1 Elaborating on the Concept of Information Risk

All public firms are required to release an annual financial statement listing earnings and expenses incurred during a revenue cycle. The reported earnings and expenses consist of (a) completed transactions for which a firm has already made or received payments, and (b) incomplete transactions for which a firm will pay or receive payments in future revenue cycles, otherwise known as accruals. Accruals are the estimated earnings and debt in a financial statement. Investors demand higher rate of return premiums when they lack confidence in reported numbers and suspect misstatements due to

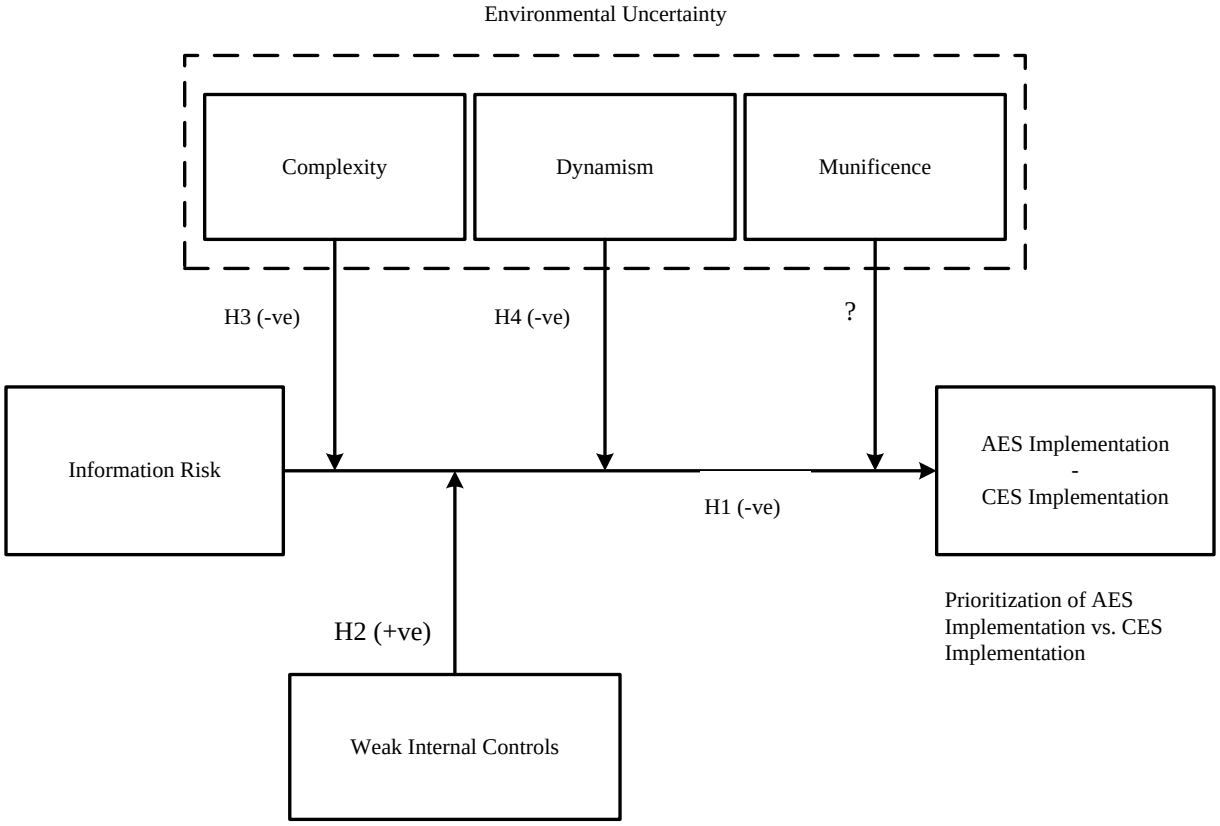


Figure 2.2 Research Model

incorrect estimation of accruals. This lack of confidence is due to a lack of reliable information (e.g., lack of access to sources that can confirm the transactions) regarding the accuracy of the estimated accruals (Francis et al. 2005; Gray et al. 2009). Information risk is considered to be high for a firm when its investors do not have sufficient information pertaining to the financial statements as compared to other stakeholders (e.g., other investors, firm management of a firm.).

Information risk is estimated by using accruals quality as a proxy. The lower the quality of accruals, the higher the information risk (Dechow et al. 2002; Francis et al. 2005). Accruals consist of two factors: account payables and account receivables. Account payables are the expenses incurred by a firm but not yet paid for. Account receivables are the reported earnings for which a firm is yet to receive payments. Accruals quality is used as a proxy for information risk because unlike completed transactions that can easily be investigated and accounted for, accruals are not easily verifiable. The quality of the accruals—that is, the likelihood that estimated accruals are accurate—represents the extent of information risk associated with a firm's financial statements.

Influence of Information Risk on the Prioritization of AES Implementation vs. CES Implementation: A firm is considered to be aggressive in attracting investor attention when more than expected growth in its earnings is due to abnormally large accruals. While such a firm may attract risk-seeking investors, its financial statements are considered unreliable by risk-averse investors. Conversely, a firm is considered to be conservative when it reports low or negative earnings from accruals. Such a firm does not rely on future earnings to attract investors. Moreover, risk-neutral and risk-averse investors are likely to view the firm's financial statements favorably. However, regardless of their risk orientation, investors prefer to reduce uncertainty and gather as much information as possible pertaining to firms' finances (Dow et al. 1992; Gray et al. 2009; Leuz et al. 2004).

Investors secure their investments by demanding higher return premiums. The cost of capital, i.e., the minimum returns expected by investors from a firm's stock, increases with an increase in information risk (Francis et al. 2005; Lambert et al. 2007). A higher cost of capital leads to reduced profit margins, lower returns for investors, increased liabilities, reduced reserves, and reduced funds for future investments that preclude firms from gaining a competitive edge. It is, therefore, important that firms improve the internal information environment and reduce the level of information risk. In addition to more reliable financial statements, better quality financial information also leads to more effective coordination between firms and their investors with respect to capital investment decisions (Leuz et al. 2004).

Enterprise systems are suggested as an effective tool to improve a firm's internal information environment (Dorantes et al. 2013). Enterprise systems can facilitate both intrafirm and the interfirm coordination by assisting firms in (a) improving core firm processes such as accounting, supply chain, human resources, and customer relationship management, and (b) generating the necessary information from these processes for managerial decision-making. We differentiate between the roles of CES and AES in producing financial reports. Data pertaining to various business transactions (e.g., supply chain, human resources, customer relationship management) is generated through and consolidated by using CES. In contrast, financial information including earnings estimations is generated by using AES but relies on transaction data that is generated through CES use. For example, supply chain ES enables a firm

to track interfirm transactions regarding purchased materials, logistics, and supplier information (Rai et al. 2006). The relevant information regarding payment schedules and cash transfers is produced by using AES. All financial transactions are processed and cumulative financial information is produced by using AES (Dorantes et al. 2013). The information environment of a firm, therefore, relies on both AES and CES use.

With increasing information risk, it becomes important for firms to allocate resources to ES capabilities to increase the quality of financial information. Although information risk is specific to the business domain of accounting and finance, the quality of financial information depends on the quality of transaction information from different functional domains. This dependency is likely to lead firms to focus on CES implementations to establish the transaction data resources required to generate quality financial information. As such, while AES are the focal technology needed to disclose accurate information in financial statements, CES provide critical information to AES for consolidation and reporting. These arguments lead to our first hypothesis.

H1: *With an increase in information risk, the implementation of CES will be greater than the implementation of AES*

2.4.2 Moderating Role of Internal Controls

Both information risk and weak internal controls represent the risk of a misstatement in a firm's financial statement. While information risk refers to misstatements due to the inaccurate estimation of expected earnings and expenses, weak internal controls refer to the inability of internal controls to eliminate the possibility of material errors in financial statements.

Internal controls are contingent upon a firm's accounting, finance, and IT processes pertaining to financial reporting. A firm's disclosure of a material weakness means that its internal controls are weak. Firms with weak internal controls are unable to prevent or detect material misstatements in their financial statements in a timely manner. Financial statements of firms with weak internal controls are not considered to be reliable (Li et al. 2012; Lin et al. 2011).

Numerous corporate scandals such as Enron and WorldCom were attributed to weak internal controls. Weak internal controls lead to serious risks for firms, their investors, and other stakeholders.

Firms become financially unstable (Folkerts-Landau et al. 1998; Ge et al. 2005; Shi et al. 2011), investors incur losses (Petrovits et al. 2011; Schneider et al. 2008), business partners fall behind competition, customers may not obtain services already paid for, and sensitive information for one or more stakeholders can be compromised (COSO-Framework 1992)[3]. For example, weak internal controls at J.P. Morgan Chase due to improper trading in 2012 led to a $459 million error in reporting income, loss of $5.8 billion in revenue, the layoff of 3000 employees to recover from the losses, and a decline in the bank's risk management reputation[4]. In 2013 it had to pay an additional $9 billion in fines and penalties and $4 billion for consumer relief[5]. Similarly, weak internal controls due to material weaknesses in IT and the improper segregation of duties at the US Internal Revenue Service (IRS)[6] resulted in a security breach of 75 GB of data where 3.8 million social security numbers, 3.3 million bank accounts, 5000 credit card numbers and other sensitive information for 699,900 businesses were hacked[7].

Clearly, strong controls are crucial for firms to release fair and accurate financial statements, protect their investors' interests, and their reputation in the market. However, sustaining strong controls can be burdensome and expensive for firms (Zhang 2007). Strict regulatory laws such as SOX ensure that firms place effective internal controls over financial reporting by mandating their managements and auditors to independently test and publicly disclose the state of internal controls. The establishment, maintenance, and testing of internal controls require IS that support all the functions underlying financial reporting, i.e., accounting, finance, and IT. Accounting enterprise systems facilitate compliance to SOX by integrating all the three domains.

In our first hypothesis, we reasoned why information risk increases the likelihood that firms will prioritize CES implementations over AES implementations. We suggest that weak internal controls will lead firms facing increasing information risk to place greater emphasis on AES implementations over CES implementations. Although firms with information risk require access to quality transactional information across business domains to improve financial reporting and information risk, the accounting

[3] See http://smallbusiness.chron.com/signs-symptoms-lack-internal-control-business-51658.html
[4]See Fox Business Report at http://www.foxbusiness.com/industries/2012/08/09/jpmorgan-files-formal-1q-restatement/
[5] See CNN Money Report http://money.cnn.com/2013/10/19/investing/jpmorgan-settlement/
[6]See Government Accountability Office Report at http://www.gao.gov/assets/590/589399.pdf
[7] See http://www.pcworld.com/article/2015543/irs-blamed-in-massive-south-carolina-data-breach.html

and financial processes provide the capabilities to process the data and generate various financial reports including earnings estimates. As such, in the presence of weak controls, the core processes of accounting and finance and its IT enablement through AES implementation will be the focus of management, and this focus is likely to be increased when a firm sees increases in information risk. Thus, when firms with high information risk also face weak internal controls, we expect that they will favor AES implementations over CES implementations. This leads us to our second hypothesis:

H2: *With an increase in information risk, the implementation of AES will be greater than the implementation of CES for firms that have weak internal controls*

2.4.3 Moderating Role of Environmental Uncertainty

Environmental uncertainty refers to the complexity, dynamism, and munificence of the industry environment in which firms operate. The higher the EU, the more difficult it can be for firms to (a) coordinate across business units, (b) assimilate accurate transaction information from business units and functional domains, (c) determine strategies to capture growth opportunities, (d) ascertain market supply and demand, and (e) manage operations and estimate the outcomes of the decisions pertaining to resource allocations (Dess et al. 1984; Eisenhardt 1989a; Flynn et al. 1999; Keats et al. 1988; Xue et al. 2011). Thus, apart from accurately reporting earnings and expenses, EU presents numerous other challenges that span multiple functional domains and business units. Hence, it can be even more difficult to address information risk, when EU is also high. Research shows that ES can be an effective technology that help firms address these challenges and help them perform effectively in uncertain environments (Dorantes et al. 2013; McAfee 2002).

It is important to adopt a nuanced perspective to understand the role of EU in moderating the relationship between information risk and the prioritization of AES implementation versus CES implementation. Environmental uncertainty can be unpacked into complexity, dynamism, and munificence, with each of them shown to have an idiosyncratic relationship with different facets of IT (Xue et al. 2011). Accordingly, we examine how each of the EU factors moderates the influence of information risk on the prioritization of AES versus CES implementations.

2.4.4 Moderating Role of Complexity

Complexity of the environment refers to the heterogeneity and the scale of the task environments within which a firm operates. The greater the complexity of the environment, the higher the uncertainty on the supply/competition side. Firms operating in highly complex environments engage with large numbers and variety of stakeholders, which makes the decisions regarding allocation and optimal use of resources difficult. Firms have to deal with large amounts of diverse information across functional domains and business units. Managing the information and knowledge becomes challenging with the increase in the information processing requirements. As such, firms have to depend on an array of IT resources to manage their operations and information processing tasks (Dess et al. 1984; Wade et al. 2004). Dealing with critical contingencies of complexity requires increased use of ES that facilitate the flow of information across functional domains and business units, best provided by CES.

The role of CES expands with the need for better quality and range of information across functional domains. Use of complementary enterprise systems helps firms exchange information with external stakeholders as well as internal stakeholders across functional domains. For example, customer relationship ES can help a firm to engage external stakeholders (customers) by exchanging information regarding the range and price of products or services the firm offers. Customer Relationship ES can be used to track the history of repeated sales to its customers, perform sales promotion analysis, and estimate future sales. The information needed to estimate availability of products or services for future consignments to be sent to customers, however, is obtained by using Supply Chain ES (Ranganathan et al. 2006).

Complementary enterprise systems can be used to develop a firm's capability to absorb external information and coordinate its competitive responses (Keats et al. 1988; Wade et al. 2004). Accounting enterprise systems, on the other hand, can be used to extract information from the corresponding CES systems to produce financial information. Thus, access to ES in different domains via CES should take priority over AES with increases in environmental complexity, leading us to hypothesize:

H3: *With an increase in information risk, the implementation of CES will be greater than the implementation of AES for firms that operate in highly complex environments*

2.4.5 Moderating Role of Dynamism

Dynamism refers to the turbulence and unpredictability of the changes in the environment within which a firm operates. The greater the dynamism in the environment, the higher the uncertainty on the demand/consumer side (Keats et al. 1988; Wade et al. 2004). Firms face progressively difficult administrative challenges as dynamism in the operating environment increases. Firms find it difficult to buffer input supplies, obtain long-term contracts with their clients, and collude with their competitors to control prices.

Ever since industrial economies have evolved with increased use of technology, the degree of interdependence has increased among firms operating within and across industry groups. Firms require a greater scope and scale of information to be processed across functional domains to cope with dynamic environments. The capabilities and IT assets required to perform effectively in turbulent and unpredictable environments are different from those required to do so in relatively stable environments. It becomes difficult for firms to predict and plan for changes without a high degree of interconnectedness between systems and cross-functional information across business units (Dess et al. 1984; Wade et al. 2004).

Complementary enterprise systems can enable a firm to expand its capacity to effectively and efficiently processing large volumes of information and interconnected capabilities across functional domains (Karimi et al. 2007b; Ranganathan et al. 2006). While AES use can provide useful support to firms to function in dynamic environments, it is CES use that can enable firms to develop the ability to quickly identify and respond to fluctuating and turbulent consumer demand and expectations. Thus, we hypothesize:

H4: *With an increase in information risk, implementation of CES will be greater than implementation of AES for firms that operate in highly dynamic environments*

2.4.6 Moderating Role of Munificence

Munificent environments are characterized by rapid yet sustained and stable growth opportunities for firms (Dess et al. 1984). Munificence is measured by the extent of growth in firm sales and income. Unlike complex and dynamic environments, in munificent environments, firms' shift their focus from

survival in the market to strengthening their competitive position. Firms are able to attract large number of investors in munificent environments. To keep investors informed of their financial health, it is important for firms to reduce agency risk by tracking accruals, and accurately estimating and disclosing earnings (Biddle et al. 2009).

Firms are scrutinized by investors when they report higher than expected earnings through accruals. Since munificent environments are considered stable, domain specific information challenges can be relatively subdued. Firms concentrate on meeting the expectations of their investors and providing them with accurate financial information (Ball et al. 2008). Using AES enables firms to effectively and efficiently collect and process financial information. Thus, with an increase in the level of munificence in the environment, firms are likely to prioritize the implementation of AES over CES.

Conversely, it can also be argued that with strong growth, firms find new business partners and expand their client base in munificent environments. In such situations, they are more likely to expand their IT capabilities to keep up with the growth. With the increase in the number of stakeholders, firms' information processing needs also increase (Wade et al. 2004). Firms may be required to have access to sophisticated and interconnected systems such as CES. Thus, we recognize munificence to be a factor of EU but do not hypothesize its relationship in favor of either AES or CES. We, however, evaluate its influence on the relationship between information and risk and the prioritization of AES vs. CES implementation.

2.5 Data Collection and Analysis

2.5.1 Panel Dataset Construction

A panel dataset was constructed using data from the following three sources: (1) *CI Technology Database* (CI) which provides data on AES implementations, CES implementations, and other IT variables; (2) Audit Analytics (AA) which provides data for internal controls; and (3) Compustat (CS) which provides data about EU and firms' financial variables.

We first collected data on SOX 404 reports from AA. Our initial sample included 62,828 firm-year observations for 16,765 firms for the years 2004 through 2012. We then matched the AA data with data available in CS. This resulted in 45,303 firm-year observations for 8,901 firms between the years

2001 and 2012 and for which CS had corresponding EU and financial metrics data available. Next, we matched these firm-year observations with data available from CI about all ES (i.e., AES, and CES). This exercise produced 2,604 firm-year observations for 883 firms between the years 2004 and 2008 and resulting in a four-year panel data set.

Measures: Table 2.1 summarizes the constructs for the dependent and the independent variables. The constructs and their measurements are elaborated next.

Table 2.1. Constructs, Measures and Descriptions

Construct	Measure and Description
Balancing between enterprise systems	Difference between the extent of AES implementations and the extent of CES implementations
Information risk	Total current accruals regressed on the cash flow, revenue, and changes in revenues, property, plant and equipment. Then the standard deviation of the residuals over the last five years.
Weak internal controls	1 if a firm had a material weakness in its internal control processes either in the past or during the current year; 0 otherwise.
Complexity	**Four Firm Concentration:** Log of the reciprocal of the ratio of the sales of the top four firms in an industry to the sales of all firms in that industry in the given year.
	Herfindahl Index: Log of the reciprocal of Herfindahl index for each industry.
Dynamism	**Sales Volatility:** Natural logarithm of total sales of four digit SIC industries regressed against an index variable of years over the five years of the sample. Then, the antilog of sales standard error at an industry level.
	Income Volatility: Natural logarithm of total operating income of four digit SIC industries regressed against an index variable of years over the five years of the sample. Then, the antilog of income standard error at an industry level.
Munificence	**Sales Growth:** Natural logarithm of total sales of four digit SIC industries regressed against an index variable of years over the five years of the sample. Then, the antilog of sales coefficient at an industry level.
	Income Growth: Natural logarithm of total sales of four digit SIC industries regressed against an index variable of years over the five years of the sample. Then, the antilog of income coefficient at an industry level.

Dependent Variable: Our dependent variable is the difference between the implementation of AES and CES in firms. It was measured using the following two-step approach: (1) computing AES and CES implementation scores, and (2) computing the difference between AES and CES implementations.

Step 1: Computing AES and CES Implementation Scores: Data related to ES implementations and other IT variables were collected from the CI database for Fortune 1000 firms. The CI database includes data collected at the site level of a firm for sites with at least 50 employees. Five classes of ES identified in the CI database are: Accounting, Human Resources, Supply Chain, Customer Relationship, and other.

Enterprise system implementation scores for each of the five types of ES were computed as the ratio of the number of sites of a firm that implemented ES to the total number of firm sites. Thus, the AES implementation score was computed as the ratio of the number of sites of a firm that had implemented AES to the total number of firm sites. The complementary enterprise system implementation score was computed as the average of implementation scores for the following types of ES: human resources, supply chain, customer relationship, and other ES.

Step 2: Computing the Difference between AES and CES Implementation Scores: AESdifferenceCES is the difference between the extent of AES implementation and CES implementation. The intuition is that when the coefficient of a predictor variable in the regression is positive, it affects the ES implementation balance decision in favor of AES. When the coefficient is negative, it leads to increased prioritization for implementation of CES over AES. A non-significant coefficient suggests that the predictor variable either has no impact or it has a similar impact on both the AES and the CES implementations.

Independent Variables: Our independent variables were information risk, weakness of internal controls, and the three EU factors: complexity, dynamism, and munificence. We now discuss each of these measures.

Information Risk: Accruals quality was used as a proxy for information risk. We computed accruals quality following Francis et al. (2005). To calculate accruals quality, a firm's total current accruals were regressed on its cash flows. The residuals obtained from the regression were then used to determine the accruals quality. The residuals are unknown factors that contribute to the total current accruals. The more the unknown factors fluctuate, the more difficult it is for investors to rely on a firm's estimated accruals. The standard deviation of the residuals is used as a measure for accruals quality. The higher the standard deviation, the lower the accruals quality, and the higher the information risk.

Measuring Weak Internal Controls: Weak internal controls is measured by material weakness in the internal controls processes. We classified a firm as having weak internal controls if it reported a material weakness in its internal controls either in the current or in any of the previous years within our sample. For example, if we have data for a firm for the years 2005 through 2008, and it reported a

material weakness only in the year 2007, then it is coded to be a firm with weak internal controls in the years 2007 and 2008 (WeakControls =1). For the years 2005 through 2006, the variable WeakControls is coded as 0 for the firm.

Measuring Environmental Uncertainty: We followed Xue et al. (2011) to compute the measures for each of the three EU factors and discuss these measures below.

Complexity was assessed using two measures of market concentration: a four-firm concentration ratio and Herfindahl index. We use the log value of the reciprocal of the four-firm concentration and Herfindahl index, so that large values of these measures indicate more complexity and small values indicate less complexity. Both measures were computed for the four-digit SIC codes of the firms in our sample.

Dynamism was measured by the volatility of the industry's income and sales. Natural logarithms of operating income and sales of four-digit SIC industries were regressed on an index variable of years, for a five-year period. Dynamism was then computed by taking the antilog of the standard error of the two regressions. The idea is that the standard error provides an estimate of the turbulence and uncertainty of the income and sales growth rate.

Munificence was measured by the growth in industry income and sales. Natural logarithms of operating income and sales of four-digit SIC industries were regressed on an index variable of years, for a five year period. Munificence was then computed by taking the antilog of the regression coefficient of the two regressions. The idea is that the regression coefficient provides an estimate of the income and sales growth rates.

We evaluated the convergent and discriminant validity of the EU measures through principal component analysis. Specifically, we used *Varimax Rotation* to extract the dimensions of EU represented by the measures. The factor loadings indicate strong support for the three identified EU dimensions (Table 2.2). We computed an index score for each factor by computing a unit mean of the measurement items[8].

[8] We also computed single item measures using a weighted average of the measurement items (weighted by factor loadings). Since the factor loadings are nearly equal in all cases, the values of single item measures using an average and the values using weighted average were identical up to four decimal points for each EU dimension.

Table 2.2 Measurement of Environmental Uncertainty

Measure					**Correlations**					**Varimax Loading**		
	Mean	Std.	Min	Max	1	2	3	4	5	CPX	DYN	MUN
Complexity[9] (CPX)												
1. 4-firm concentration	0.25	0.28	0.00	1.94						**0.97**	-0.03	0.06
2. Herfindahl index	1.44	0.66	0.03	4.37	0.91					**0.98**	-0.02	0.04
Dynamism (DYN)												
3. Sales volatility	1.04	0.10	1.00	3.75	-0.06	-0.07				-0.08	**0.72**	0.09
4. Income volatility	1.08	0.13	1.00	2.54	-0.03	0.00	0.18			0.04	**0.81**	-0.03
Munificence (MUN)												
5. Sales growth	1.07	0.10	0.66	1.65	0.07	0.05	0.09	-0.06		0.01	-0.04	**0.91**
6. Income growth	1.10	0.18	0.60	3.11	0.11	0.09	0.04	0.12	0.63	0.08	0.11	**0.89**
Average Variance Extracted										0.95	0.60	0.82

Control Variables: Following prior literature, we include a set of control variables in our model (Dewan et al. 2011; Feng et al. 2009; Li et al. 2012; Zhang 2006). Firms that are older are more likely to have implemented ES and are experienced in devising IT implementation strategies. Hence, we control for firm age (FirmAge), measured by the number of years a firm has been traded on a stock exchange (Zhang 2006). The more profitable a firm, the more likely it is to invest in ES. Thus, we control for sales growth (SalesGrowth: growth in sales from year t-1 to year t) and leverage (Leverage: ratio of total liabilities to total assets) (Li et al. 2012). Firms that have several operational and geographical segments are more likely to have an ES implementation strategy in place. We include a natural log of total segments (SegmentsLn) as a control variable. Firms with foreign transactions are likely to rely on various ES. We include a binary measure for foreign (Foreign: 1 if a firm has foreign transactions in year t, 0 otherwise). Firms' ES implementation decisions can change based on whether they experience large changes in the return on assets. We include absolute change in ROA (ABSCHGROA) from year t-1 to year t, as a control variable. Since we are examining the role of information risk in ES implementations, it

[9] We also evaluated dynamic concentration as a measure for complexity. Its loadings were 0.24 with complexity, -0.64 with munificence and 0.09 with dynamism. It was dropped due to low loading with complexity and cross-loading with munificence.

is important to control for firm risk's impact on ES implementations. We control for firm risk (FirmRisk), calculated as the standard deviation of quarterly ROA of the year following the year of observation (Dewan et al. 2011). Firms that have large IT capital are also more likely to have implemented ES and have mature ES implementation strategies. Thus, we control for IT capital (IT_Capital) measured as (computer capital + 3* IT labor cost)/ total assets (Dewan et al. 2007b). Lastly, we include year dummies as controls. We did not include total assets due to high VIF. However, we include several variables (Leverage, SegmentsLn etc.) that account for total assets and address the size of the firm. The mean VIF was 2.29 and all VIFs were less than 9. Table 2.3 shows the descriptive statistics and pairwise correlations of the variables.

2.5.2 Empirical Specification

The empirical specification of our model is shown below[10] in equation 1. The subscript *i* denotes a firm and the subscript *t* denotes the year. We evaluate the dependent variable in year *t+1* and the independent variables and control variables in year *t*. The data for the dependent variable was for years 2005 through 2008, and the data for the independent variables and control variables was for years 2004 through 2007.

Equation 2-1

$$AESdifferenceCES_{i(t+1)} = \beta_0 + \beta_1 (Controls)_{(it)} + \beta_2 InfoRisk_{(it)} + \beta_3 WeakControls_{(it)} + \beta_4 CPX_{(it)} + \beta_5 DYN_{(it)} + \beta_6 MUN_{(it)} + \beta_7 InfoRisk \boldsymbol{X} WeakControls_{(it)} + \beta_8 InfoRisk \boldsymbol{X} CPX_{(it)} + \beta_9 InfoRisk \boldsymbol{X} DYN_{(it)} + \beta_{10} InfoRisk \boldsymbol{X} MUN_{(it)} + \varepsilon_{(it)}$$

[10] Information risk, complexity, dynamism, and munificence are mean centered

Table 2.3. Descriptive Statistics and Pairwise Correlation Matrix

#	Variable	Mean	StDev	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	AESdifferenceCES	0.33	0.22	-0.75	1.00																	
2	FirmAge	30.45	20.52	1.00	82.00	-0.09*																
3	Leverage	0.56	0.22	0.05	2.32	-0.08*	0.12*															
4	SegmentsLn	2.13	0.79	0.00	4.39	0.01	0.09*	-0.07*														
5	Foreign	0 (44.78%)		1 (55.22%)		0.01	0.02	-0.10*	0.50*													
6	ABSCHGROA (x100)	0.76	1.09	0.00	9.35	0.01	-0.09*	0.08*	0.04*	0.03												
7	FirmRisk (x100)	0.82	1.21	0.00	17.68	0.01	-0.07*	0.12*	-0.01	0.00	0.56*											
8	SalesGrowth	0.12	0.20	-0.59	2.80	0.03	-0.10*	-0.08*	0.05*	0.03	0.04*	-0.06*										
9	IT_Capital	0.02	0.04	0.00	0.81	-0.02	-0.11*	-0.04*	-0.09*	-0.02	0.02	0.00	-0.08*									
10	InfoRisk	0.00	0.07	-0.06	1.95	-0.02	-0.15*	-0.01	-0.05*	-0.03	0.18*	0.09*	0.12*	0.01*								
11	WeakControls	0 (83.22%)		1 (16.78%)		0.00	-0.01	0.02	0.05*	0.05*	0.14*	0.11*	-0.07*	0.08*	0.06*							
12	CPX	0.00	0.57	-1.07	2.07	-0.01	0.07*	0.08*	-0.11*	-0.10*	-0.04	-0.02	-0.01	-0.08*	-0.02	-0.04*						
13	DYN	0.00	0.07	-0.05	1.36	-0.01	-0.02	-0.06*	0.02	0.04*	0.07*	0.03	0.06*	0.01	0.10*	0.01	-0.07*					
14	MUN	0.00	0.11	-0.46	0.95	0.02	-0.05*	-0.12*	0.13*	0.10*	0.03	0.00	0.19*	-0.01	0.07*	-0.03	0.01	0.15*				
15	InfoRisk ***X*** WeakControls	0.00	0.03	-0.06	0.58	0.02	-0.08*	0.00	-0.01	0.01	0.08*	0.06*	0.04*	0.05*	0.42*	0.10*	0.01	0.04*	0.02			
16	InfoRisk ***X*** CPX	0.00	0.04	-0.42	1.14	-0.03	0.01	-0.02	0.07*	0.08*	0.03	0.05*	0.02	-0.01	0.17*	0.02	-0.15*	-0.01	0.04*	0.13*		
17	InfoRisk ***X*** DYN	0.00	0.00	-0.05	0.09	-0.03	0.00	-0.04	0.01	0.01	0.05*	0.01	-0.01	-0.03	-0.14*	0.00	-0.01	0.45*	0.10*	-0.04*	-0.11*	
18	InfoRisk ***X*** MUN	0.00	0.01	-0.06	0.19	-0.02	-0.01	0.01	0.00	0.01	0.00	0.00	0.08*	-0.01	0.42*	-0.01	0.04*	0.08*	0.15*	0.03	0.22*	0.02

* Significant at 0.05 level

2.5.3 Analysis and Results

We first conducted the Breusch-Pagan Lagrange Multiplier test that confirmed the panel structure of the data. Then, we conducted the Hausman test that ruled out a fixed-effects model. Our data has an unbalanced panel structure. Since the dependent variable is computed as the difference between two ratios (i.e., function of fractions), we use the Generalized Least Square regression[11] (Wooldridge 2009). Table 2.4 shows the results. Column 1 shows the baseline control model. Column 2 shows the main effects model. The results of the full model are shown in column 3. The main effect of information risk is negative and significant, suggesting that with an increase in information risk firms prioritize the implementation of CES over AES. Thus, H1 is supported.

The interaction effect of information risk and internal controls is positive and significant, and supports H2. The interaction plot is shown in Figure 2.3. As hypothesized in H2, the positive sloping line shows that firms that have weak internal controls prioritize implementation of AES over CES when faced with increasing information risk. The negative sloping line, on the other hand, is for firms that do not have weak internal controls, i.e., *WeakControls* = 0. This line represents the main effect of information risk. It shows that with an increase in information risk, implementation of CES is greater than implementation of AES.

The coefficients of the interaction effects for complexity and dynamism with information risk are negative and significant, supporting H3 and H4, respectively. Negative sloping lines in Figures 2.4 and 2.5 are for firms that operate in highly complex and dynamic environments. Our findings, thus, show that with an increase in information risk, implementation of CES is greater than implementation of AES for firms that operate in environments that are highly complex and dynamic. The slopes for firms that operate in environments that are low in complexity and dynamism are relatively flat and do not suggest prioritization in implementing AES or CES.

[11] We use the STATA command xtgls. Several prior studies have used GLS. For example see Kwortnik et al. (2009), Rai et al. 2009, and Poppo and Zenger (2002)

Table 2.4. Generalized Least Square Regression Results

AESdifferenceCES			
	1	2	3
InfoRisk***X***WeakControls			0.2760092 (0.1616874)**
InfoRisk***X***CPX			-0.2330299 (0.123159)**
InfoRisk***X***DYN			-2.563356 (1.141959)**
InfoRisk***X***MUN			0.2186323 (0.6561455)
InfoRisk		-0.085693 (0.0620863)	-0.1514203 (0.0779323)**
WeakControls		-0.0021188 (0.0119066)	-0.0034575 (0.0119197)
CPX		0.0013154 (0.0078103)	-0.0011166 (0.0079193)
DYN		-0.0179748 (0.0607048)	0.0455527 (0.0680116)
MUN		-0.0170688 (0.0406479)	-0.0115454 (0.0408195)
FirmAge	-0.0009412 (0.0002188)***	-0.0009872 (0.00022)***	-0.000973 (0.00022)***
Leverage	-0.0694223 (0.0202503)***	-0.0686036 (0.0203721)***	-0.0695092 (0.0203472)***
SegmentsLn	0.0050031 (0.0064934)	0.0051051 (0.0065409)	0.0053819 (0.006531)
Foreign	-0.0041684 (0.0101731)	-0.0044467 (0.0101765)	-0.0044218 (0.0101717)
ABSCHGROA (x100)	0.0005837 (0.0049152)	0.00177 (0.0049775)	0.0025034 (0.0049984)
FirmRisk (x100)	0.0016539 (0.0044437)	0.0020641 (0.0044426)	0.001998 (0.0044415)
Sales Growth	0.0175003 (0.0226017)	0.0317454 (0.0233172)	0.0299978 (0.0232856)
IT_Capital	-0.1705878 (0.1227994)	-0.1333595 (0.1238308)	-0.1465438 (0.1237201)
YearDummies	Included	Included	Included
Constant	0.3834111 (0.0188716)***	0.3605929 (0.021802)***	0.3610951 (0.0217905)***
Wald Chi-square	36.42***	51.19***	61.54***
Log Likelihood	216.64	223.91	228.97
Firms (Firm-year observations)	883 (2604)	883 (2604)	883 (2604)

*****p<0.01 ** p<0.05 * p<0.1; one-tailed test given directional effects are hypothesized**

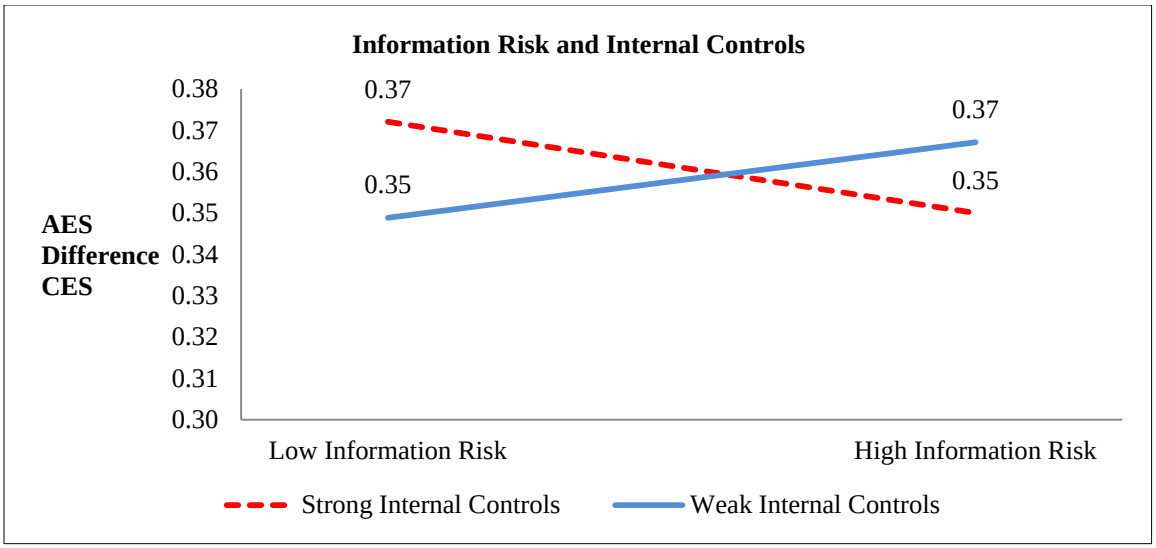


Figure 2.3. Interaction Effect of Information Risk and Internal Controls

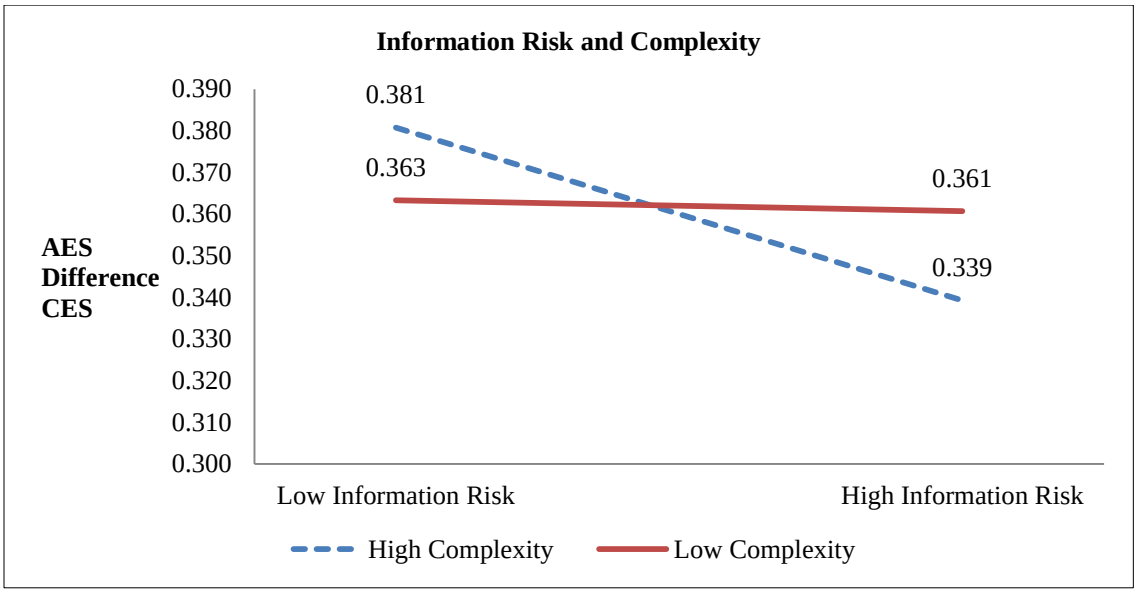


Figure 2.4. Interaction Effect of Information Risk and Complexity

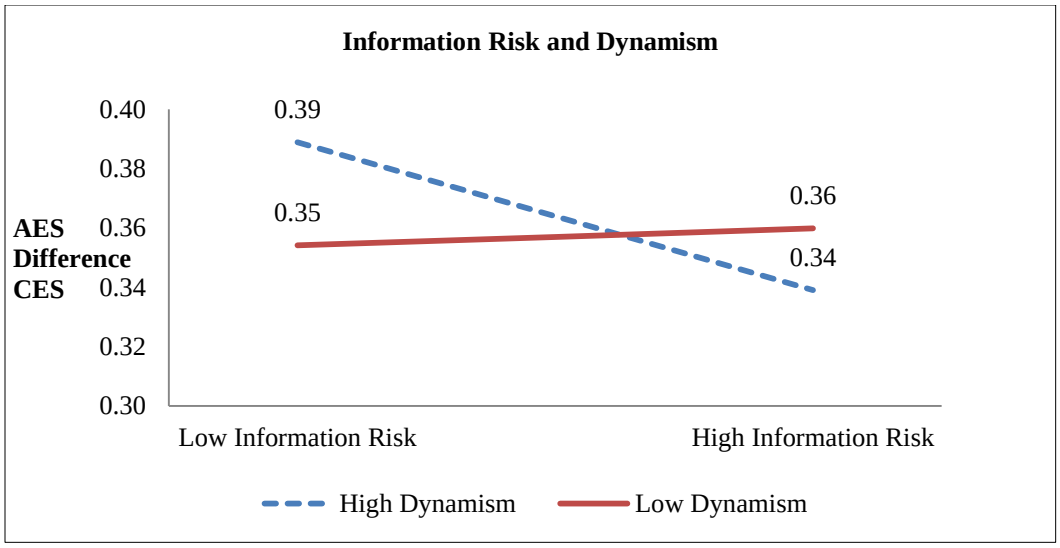


Figure 2.5. Interaction Effect of Information Risk and Dynamism

Although we did not hypothesize an interaction between information risk and munificent environments, we evaluated the interaction and found it to be non-significant.

2.5.4 Robustness Tests

Prioritization of AES vs. CES may be endogenous. It is likely that how firms prioritize AES implementation vs. CES implementation influences information risk. It is also possible that in addition to AES and CES implementations, other factors influence information risk, and thus AES and CES implementations may be endogenous. As endogeneity can lead to biased estimates (Greene 2003; Wooldridge 2009), we performed a two-stage Heckman analysis to evaluate for the presence of endogeneity (Heckman 1979; Shaver 1998). The results of the stage 1 Heckman analysis indicate that prioritization of AES is endogenous. After correcting for endogeneity in stage 2 of the Heckman analysis, the coefficients and directions of all the independent variables were consistent with the original analysis. The details of the Heckman analysis are discussed in Appendix 2.A.

2.6 Discussion

2.6.1 Implications for Theory

Our results reveal how information risk influences the prioritization of AES and CES implementations and how this influence changes with a firm's internal controls and the characteristics of its external environment. Our results have three key implications for our understanding of the factors that

lead firms to prioritize the allocation of IT resources to a focal process domain (AES for accounting and financial processes) or to complementary process domains (CES for supply chains, customer relationship, human resources, and others).

First, our study extends our understanding of a firm's characteristics that affect IT implementation choices by revealing the significant role played by information risk, a salient consideration for a firm's external stakeholders. Our findings reveal that information risk is associated with a firm prioritizing the implementation of CES over AES. The level of information risk depends on firms' ability to collect financial and performance information across functional domains. When firms are unable to collect and integrate this information, their ability to accurately estimate earnings and expenses is compromised. Consequently, firms' investors and stakeholders are likely to perceive them to be risky investments. Our findings suggest that firms faced with information risk place greater emphasis on improving their information environment by prioritizing the implementation of CES to collect cross-domain transaction information that is critical to core accounting and financial processes that present financial information to external stakeholders.

Second, the findings from our study show that internal controls moderate the influence of information risk on the prioritization of AES versus CES implementations. Although past work has examined the impact of ES on internal controls and information risk (Bedard et al. 2012; Dorantes et al. 2013), our study shows that a firm's choices to prioritize ES in the accounting and finance domains or in complementary business domains are jointly influenced by information risk and internal controls. To elaborate, information risk means that firms' expected earning and expense estimates may not be accurate. Although we found that a firm faced with information risk prioritizes CES implementations to expand access to quality transaction information from across business domains in order to improve the quality of financial statements and earnings information, weak internal controls point to concerns about the accounting and financial processes of the firm. When a firm faces increases in information risk *and* its internal controls are a source of weakness, it faces a greater need to improve the quality of its core accounting and finance processes. Under these conditions, firms are more likely to prioritize ES

investments in the core processes (i.e., AES investments) relative to prioritizing ES investments in complementary process domains that are sources of transactional information to the finance and accounting process.

Third, our study expands our understanding about how firm-specific factors and environmental factors jointly influence a firm's ES implementations. Our findings reveal that high levels of environmental complexity and environmental dynamism amplify the effect of information risk to prioritize CES implementations over AES implementations. These finding suggest that the environmental context moderates the influence of a firm-specific factor (i.e., information risk) on the firm's IT choices.

Firms operating in complex environments have a need to collect and process complex information. This need to process complex information arises due to the large number of interdependencies within and across a firm. Our results suggest that firms with high information risk situated in complex environments prioritize CES implementations over AES implementations as they have a greater need to digitize cross-functional processes and establish an integrated view of information across domains that is relevant to the financial and accounting processes.

Firms operating in dynamic environments need the ability to respond to fluctuating consumer demands. Firms need to have access to a wide variety of information pertaining to their customers' buying behaviors. They also need to pass on real-time information to their suppliers in order to minimize order lead-times (Cotteleer et al. 2006). We find that firms with high information risk situated in dynamic environments prioritize CES implementations over AES implementations since they need to collect cross-domain information from their customers, and share information with their suppliers.

The interactions of information risk with environmental complexity and with environmental dynamism expand our understanding of how the influence of a firm-specific characteristic on the firm's IT choices depends on the environmental context in which the firm is situated. This idea is consistent with Johns' (2006) observation that context can *change* the relationship between variables and is a powerful way to elaborate theoretical understanding in a domain.

Cumulatively, our study extends past work that has examined how environmental characteristics (e.g., volume and technology uncertainty) and organizational characteristics (e.g., top management support, firm size, and firm complexity) affect IT adoption and implementation choices (Mishra et al. 2007; Rai et al. 1997a; Rai et al. 2009).

2.6.2 Implications for Practice

Our study has two important implications for practitioners. First, our study provides insights on how firms can prioritize the allocation of resources to a system that enables a function or a business process (e.g., accounting and financial reporting) or to systems that enable complementary functions or business processes (e.g., supply chain and customer relationship). Confronted with information risk, particularly in complex environments and in dynamic environments, firms need to recognize the importance of prioritizing CES implementation to establish the access to and quality of information resources required for the effective execution of interfirm processes.

Second, when firms are confronted with weak internal controls, they need to recognize the importance of prioritizing AES implementation to enable the core processes of accounting and finance that are commonly associated with information risk. They need to inform this decision not only by considering information risk but also by understanding how the IT-enablement of complementary business processes can be useful in reducing information risk and by understanding the external environment in which the firm operates. They can develop this understanding through collaboration among executives in accounting, finance, IT and other functional domains.

2.6.3 Limitations and Future Research

This study has important strengths. It uses rigorous econometric analysis on a rich data set and simultaneously evaluates the impact of firm-specific factors and environmental factors in driving firms' ES implementations. Notwithstanding the strengths, the study has some limitations. First, we do not examine the role of firms' governance structures and long-term goals —factors that may be important determinants of how firms prioritize IT resource allocation among a set of choices. Second, IT-enabled business practices evolve and change over time and the set of technologies and services that can enable

business processes continues to see rapid change. For example, big data, and cloud and mobile technologies are being touted to influence firms' digital strategies for the coming years. Future research can examine how information risk, internal controls, and environmental characteristics affect a firm's decisions to invest in ubiquitous mobile and cloud-based technologies. Future studies can extend our work by considering the roles of these factors in affecting how firms prioritize the allocation of resources to the IT enablement of a core business process or to the IT enablement of complementary business processes.

2.7 Conclusion

Our study examines how firm-specific internal factors and industry-specific external factors lead firms to prioritize ES implementations in core or complementary processes. Our findings reveal that firms prioritize CES implementation over AES implementation when faced with high information risk and high EU, specifically complexity and dynamism. We also find that when increases in information risk are accompanied by weak internal controls, firms are likely to prioritize AES implementations over CES implementations. Our study extends the resource-based theory by showing that conditions underlying a core business process and a firm's external environment jointly influence the firm's prioritization in allocating IT resources (a) to enable the work activities in the core business process or (b) to enable the work activities of complementary business processes.

2.8 Appendix 2.A — Two-Stage Heckman Analysis

We performed a two-stage Heckman analysis (Heckman 1979) to identify and correct for endogeneity. Our goal was to examine and correct for endogeneity arising from one or more of the following reasons: (a) prioritization of AES vs. CES implementation influences information risk and our model suffered from reverse causality, (b) other factors affect ES implementations and information risk, and our model had omitted variable bias issues, and (c) firms that implement ES are likely not random as certain firm characteristics may influence ES implementations and lead to self-selection bias. We used the two-stage Heckman analysis to evaluate and correct for endogeneity.

For the first stage, we divided our sample into two groups per Shaver (1979). The first group included firms with information risk above the median (i.e., high information risk) and was coded as 1 (InfoRiskMedian=1). The second group of firms had information risk below the median (i.e., low information risk) was coded as 0 (InfoRiskMedian=0). Prior studies have used similar coding schemes to divide their samples (e.g., see Bharadwaj et al. 2007; Hsieh et al. 2011).

Drawing on Dichow and Dichev (2002), we identified the predictors of information risk. Dichow and Dichev list a comprehensive set of observable firm characteristics that predict information risk. Francis et al. (2005) build on Dichow and Dichev's specifications to compute information risk. Thus, Dichow and Dichev provide a reliable set of information risk predictor variables that can be used in the first stage of a Heckman analysis. The descriptions and descriptive statistics are shown in Table 2.5. We estimated a Probit model using maximum likelihood estimation where the information risk predictors, control variables, and the dependent variable of our model – AESdifferenceCES – were regressed on InfoRiskMedian. The dependent variable in this model – InfoRiskMedian – was in year t+1. All other variables were in year t.

The correlations are shown in Table 2.6. The results of the Heckman analysis are shown in Table 2.7. Following stage 1 of the Heckman analysis, we computed the *Inverse Mills Ratio* and used it as an additional control variable for stage 2 of the Heckman analysis. For comparison, we include the results of the original analysis in the first column. The results were consistent with the original analysis. After

correcting for endogeneity, the coefficients of information risk, IT capital, and the interaction of information risk and dynamism become stronger and more significant. The coefficient for the *Inverse Mills Ratio* is negative and significant, suggesting that both the independent variable and the dependent variable of the original model are affected by the predictors of the Heckman stage 1 model (Shaver 1998 p. 582). Thus, factors that affect information risk also affect firms' strategies to balance AES and CES implementations.

Table 2.5 Descriptions and Descriptive Statistics of Information Risk Predictors

#	Variable	Description	Mean (StDev)	Min	Max
1	LnAT	Natural log of assets in year t	7.717 (1.546)	4.210	12.397
2	SalesStDev	Standard deviation of sales for years t-4 through t	0.163 (0.154)	0.004	2.743
3	CFOStDev	Standard deviation of cash flow from Operations for years t-4 through t	0.033 (0.026)	0.002	0.383
4	ΔWCStDev	Standard deviation change in working capital from the previous year for years t-4 through t	0.025 (0.022)	0.001	0.289
5	EarnStDev	Earn = Long term accruals computed as CFO + ΔWC, standard deviation years t-4 through t	0.028 (0.026)	0.001	0.437
6	Average |ΔWC|	Average of absolute value of working capital years t-4 through t	0.005 (0.024)	-0.149	0.454
7	EarnNegRatio	Proportion of earnings that are negative for each firm	0.026 (0.129)	0.000	1.000

Table 2.6 Correlations for Control Variables and Information Risk Predictors

#	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	LnAT														
2	SalesStDev	-0.13*													
3	CFOStDev	-0.27*	0.29*												
4	ΔWCStDev	-0.37*	0.27*	0.62*											
5	EarnStDev	-0.20*	0.24*	0.72*	0.44*										
6	Average |ΔWC|	-0.09*	0.06*	0.09*	0.08*	0.07*									
7	EarnNegRatio	-0.14*	0.02	0.23*	0.19*	0.30*	0.01								
8	FirmAge	0.40*	-0.13*	-0.15*	-0.14*	-0.13*	-0.01	-0.04*							
9	LEVERAGE	0.26*	0.01	-0.07*	0.04	0.00	-0.04	0.13*	0.12*						
10	SegmentsLn	0.17*	-0.11*	-0.06*	-0.10*	0.0	0.01	-0.10*	0.08*	-0.10*					
11	Foreign	0.03	-0.07*	0.01	-0.01	0.02	-0.01	0.00	0.03	-0.10*	0.50*				
12	ABSCHGROA (x100)	-0.16*	0.06*	0.29*	0.23*	0.35*	0.01	0.23*	-0.10*	0.08*	0.04*	0.03			
13	FirmRisk (x100)	-0.14*	0.03	0.21*	0.19*	0.21*	-0.01	0.21*	-0.10*	0.12*	-0.01	0.00	0.60*		
14	SalesGrowth	0.03	0.14*	-0.01	-0.10*	0.05*	0.02	-0.11*	-0.10*	-0.10*	0.05*	0.03	0.04*	-0.10*	
15	IT_Capital	-0.33*	0.11*	0.15*	0.21*	0.06*	0.00	0.04*	-0.11*	-0.04*	-0.10*	-0.02	0.02	0.00	-0.10*
* Significant at 0.05 level															

Table 2.7. Heckman Analysis Generalized Least Square Regression Results

	Original Model	**Heckman Stage 1**	**Heckman Stage 2**
Dependent Variable →	AESdifferenceCES (AES-CES in year t+1)	InfoRiskMedian (t+1)	AESdifferenceCES (AES-CES in year t+1)
Predictor Variables ↓			
LnAT		-0.1709836***	
SalesStDev		4.369819***	
CFOStDev		7.743752**	
ΔWCStDev		7.119727**	
EarnStDev		3.121658	
Average |ΔWC|		1.739785	
EarnNegRatio		0.4693851	
InfoRisk***X***WeakControls	0.2760092**		0.2939539**
InfoRisk***X***CPX	-0.2330299**		-0.2490121**
InfoRisk***X***DYN	-2.563356**		-2.932529***
InfoRisk***X***MUN	0.2186323		0.8396706
InfoRisk	-0.1514203**		-0.3305465***
WeakControls	-0.0034575		-0.0091549
CPX	-0.0011166		0.0104609
DYN	0.0455527		0.0029809
MUN	-0.0115454		-0.0334958
Inverse Mills Ratio			-0.0739453***
FirmAge	-0.000973***	-0.0011502	-0.0006064***
Leverage	-0.0695092***	0.3219383	-0.0617505***
SegmentsLn	0.0053819	0.0848266	0.0070742
Foreign	-0.0044218	-0.051869	-0.0024968
ABSCHGROA (x100)	0.0025034	0.2380521***	-0.0073669
FirmRisk (x100)	0.001998	-0.0417628	0.0011594
Sales Growth	0.0299978	0.6354368***	0.0031672
IT_Capital	-0.1465438	-2.074415	-0.225711**
YearDummies	Included	Included	Included
Constant	0.3610951***	-0.1214858	0.4101772***
Wald Chi-Square	61.54	218.57	103.65
Log likelihood	228.97	-1316.14	247.88
Firms (Firm-year observations)	883 (2604)	883 (2601)	883 (2601)

*****p<0.01 ** p<0.05 * p<0.1; one-tailed test given directional effects are hypothesized**

3 Chapter 3 — Uncovering the Business Value Creation Mechanisms of Enterprise Systems in the Internal Control Processes Context

3.1 Abstract

This study examines how the use of enterprise systems (ES) in a focal business process can be combined with competence in the business domain and the use of complementary enterprise systems (CES) in other process domains to achieve *conflicting* process performance objectives. We situate the theory development and empirical investigation in the context of a firm's internal control processes. We conceptualize internal control processes as a robust set of managerial and operational processes that safeguard against material weaknesses (MWs). Drawing on the resource-based theory, theory of complementarities, and the process-mediated IT business value perspective, we develop a model to explain the mechanisms through which Accounting Enterprise Systems (AES) in combination with other IT (CES) and non-IT (accounting managerial competence) resources can enable a firm to develop capable managerial and operational internal control processes, and improve the audit process performance.

We construct a multi-source firm-level panel dataset on a firm's AES use, CES use, material MWs, audit process performance measures, and a range of firm and industry control variables. We apply econometric and multivariate analysis procedures to test our model using a sample of 314 firms' data from 2004 through 2009 periods.

Our results reveal multiple mechanisms through which AES creates business value, assessed at the process level. First, we find AES use complemented by CES use improves process performance (specifically reduction in audit fees and delays) through improvements in managerial internal control processes but not through operational internal control processes. Second, we find AES use adversely affects internal control processes when firms lack strong accounting managerial competence. Third, above and beyond the previous two mechanisms that involve process capability as a mediator in the AES-process performance causal chain, we find AES use and accounting managerial competence to have countervailing effects in reducing audit delays. Although firms that lack accounting managerial competence can reduce audit delays by increasing AES use, it weakens their internal control processes.

Collectively, the results expand our understanding of creating IT business value at the process level and leveraging AES to develop efficient and effective internal control processes.

Keywords: Internal Controls, Enterprise Systems, Audit Process Performance, Business Value of IT, Managerial Competence

3.2 Introduction

While scholars have examined both the direct (e.g., see Bharadwaj et al. 1999; Hitt et al. 1996; Rai et al. 1997b) and the process mediated relationships of IT on firm performance (e.g., see Barua et al. 2004; Barua et al. 1995), the growing trend in recent years has been to examine the impact of IT on process performance instead. The underlying argument is that firm performance is a highly aggregated measure comprised of factors that are inconsistent across firms. In actuality, though, process performance corresponds directly to the use of IT. Further, the business value of IT derived through the process performance is often mediated by the business processes (BPs) (Drnevich et al. 2013; Ray et al. 2004), which are defined as a set of logically related tasks performed to achieve a defined business outcome (Davenport et al. 1990; Overby 2008).

Business processes digitized by IT are faster, cost efficient, and less prone to manual errors as compared to non-digitized BPs (Overby 2008) and enable firms to respond to market fluctuations and improve their ability to adapt to supply and demand uncertainties (Barua et al. 2004; Rai et al. 2006; Rai et al. 2010). Several conceptual papers (e.g., see Dehning et al. 2002; Kohli et al. 2008; Melville et al. 2004) therefore advocate, and empirical studies evaluate (Karimi et al. 2007a; Kohli et al. 2012; Tallon 2007), the value created by IT, especially ES, through innovations and improvements to the BPs that they digitize. For example, Cotteleer and Bendoly (2006) find that ES implementation leads to improved order lead time; Ayal and Seidman (2009) find that ES implementation results in improved billing, diagnostic quality, and film reduction processes; and Dorantes et al. (2013) find that ES implementation leads to improved forecasting accuracy.

In spite of advances that have increased our understanding through the adoption of a process-driven approach to examining IT business value in different technology and process contexts, there are two important gaps that we identify and focus on addressing. First, there is the need to extend the literature by examining how a given class of IT (e.g., ES) can influence different types of BPs. Indeed, this point was initially made in earlier business process reengineering literature that noted that the influence of IT on BP depends on the nature of process activities (Davenport et al. 1990). Drawing upon

Varadrajan and Yadav (2002), and Piller and Stotko's (2002) conceptualization of digitizability, we suggest that processes—like products—differ in the extent to which they can be digitized. Each BP consists of one or more process activities (Benner et al. 2003; Davenport et al. 1990), and the extent to which IT can digitize a BP depends on whether the activities are predominantly operational or managerial (Davenport et al. 1990). The influence of IT on BP digitization is likely to differ between managerial and operational BPs, where operational BPs are more amenable to digitization. However, it is not yet understood whether there is any difference in the benefits derived by managerial and operational BPs, and whether the impact of these BPs on process performance varies.

The second aspect where research falls short is in a sufficient understanding of how BPs in conjunction with other complementary resources impact process performance. While digitization can improve the performance of intermediate BPs (Barua et al. 2004; Rai et al. 2006), the nature of improvement in process performance is unclear. Indeed, the proportionality of BPs' impact on process performance is contingent on other factors. These factors may include the managerial level at which the process operates (Beneish et al. 2008; Rai et al. 2006), the number of stakeholders impacted by the process (Davenport et al. 2003), the standardizability of the process (Stetten et al. 2008), and alignment of the process with the firm's business operations (Rai et al. 2012; Ray et al. 2005).

To study the extent of IT's influence on BPs and its business value, this research examines how AES affect internal control processes, and how the internal control processes affect audit process performance. We specifically examine the internal control processes, and the associated business value generated by AES for two major reasons. First, internal control processes are distinctive not only because a firm is said to have poor internal control capabilities if it has one or more Material Weaknesses (MWs) (defined as a significant deficiency, or combination of significant deficiencies, that results in more than a remote likelihood that a material misstatement of the annual or interim financial statements will not be prevented or detected) in its internal control processes, but also because both the firm's management and external auditors are required to test them and unlike other processes their outcomes are publicly disclosed. Second, public firms responded to the stringent requirements of the Sarbanes-Oxley Act of

2002 (SOX) by making large-scale investments in their regulatory infrastructures. The largest share of this expenditure has been spent on information systems, specifically AES (InvestopediaReport 2009; Kallunki et al. 2011; Zrimesk et al. 2003)[12]. Since ES are typically known to be the large, complex, and highly demanding information systems to implement, AES consume a significant share of the regulatory infrastructure expenditures (Grabski et al. 2011).

Accounting enterprise systems can play a critical role in facilitating compliance with SOX by strengthening the internal control processes through digitization (Grabski et al. 2007; Grabski et al. 2011; Hyvönen 2003). However, in spite of the capabilities provided by AES and widely reported investments in them, their success has been uneven. While some firms have been successful in improving their internal control processes (Dorantes et al. 2013), others have had moderate to no success with AES (CIMA-Report 2004; DefenseSystemsReport 2012; Grabski et al. 2007; Granlund et al. 2002). More generally, research shows that firms incur major losses and lose their competitive edge when they fail to achieve the desired objectives from expensive ES implementations[13] (Davenport 1998; Davenport 2000). It is therefore important to examine why some firms that have implemented and used AES are able to strengthen their internal control processes and generate business value as compared to others who also have implemented and used AES and yet had MWs.

In order to understand why firms differ in the benefits they derive from the use of AES, it is important to examine how they leverage AES for their internal control processes. Research that takes the process-driven approach to examine the business value of ES emphasizes the importance of identifying the specific BP capabilities through which ES creates value (e.g., Ayal et al. 2009; Cotteleer et al. 2006). We draw on Davenport and Short's (1990), Benner and Tushman's (2003), and Davenport's (2005) classification of BPs as operational or managerial. While a BP can be a mix of managerial and operational process activities, it is considered to be operational or managerial depending on the managerial or operational predominance of the activities that constitute it. We classify the internal control processes as operational or managerial and examine the impact of AES on them. Business processes can significantly

[12] See http://www.emrisk.com/services/regulatory-compliance
[13] See http://www.pcworld.com/article/246647/10_biggest_erp_software_failures_of_2011.html

differ from one another in their orientation towards managerial or operational activities. Since not all BPs can be equally impactful on process performance (Grover et al. 2000; Kettinger et al. 1997; Mani et al. 2010), we examine the impact of AES on audit process performance mediated by internal control processes.

Drawing on the economic theory of complementarities (Milgrom et al. 1995; Tanriverdi 2006), we first evaluate the role of a firm's CES resources to assimilate AES into the managerial and operational internal control processes. A firm's CES resources reflect the emphasis given to IT within a firm and the level of preparation a firm takes to adopt and assimilate newer technologies. The more a firm emphasizes IT, the more pervasive it is across functional domains. The pervasiveness of IT across functional domains improves the technical know-how and lowers the barriers for implementing and successfully operating elaborate and complex cross-functional technologies (Attewell 1992; Brynjolfsson et al. 2000; Brynjolfsson et al. 1996). Thus, it is important to understand how firm performance will vary across firms with high and low CES resources.

Second, prior studies and auditing guidance suggest that no matter how well the internal control processes are conceived and operated, they cannot provide absolute assurance against misstatements. Internal control processes are exposed to possible faulty decision-making and breakdowns due to simple errors and mistakes. Internal control processes may not only be intentionally or unknowingly circumvented and overridden; they may also be constrained due to a lack of resources—specifically knowledge resources—or high costs of implementation and testing. Thus, over and beyond the capabilities of internal control processes, a firm's accounting managerial competence plays an important role in building strong internal control quality (COSO-Framework 1992; Lin et al. 2011).

However, it is unclear as to the nature of the relationship between managerial and operational internal control processes and human resource competence in affecting business performance. Sigglekow (2002) notes that resource allocation decisions in capability development (e.g., processes or human resource competence) needs to be based on an understanding of the complementary or substitutive effects that the given capabilities have on business performance. On one hand, it can be argued that process

capabilities and human resources are substitutive and therefore weaknesses in process controls are compensated by human resource competence. On the other hand, it can be argued that internal control processes and human resource competence are complementary, with the marginal returns from one of them increasing with the level of the other. Accordingly, we examine the complementarities of AES-enabled managerial and operational internal control processes with a firm's accounting managerial competence in affecting audit process performance. Our research objective is as following:

RO: Examine how AES use along with complementary resources impact audit process performance through the enablement of managerial and operational internal control processes

3.3 Background and Hypotheses Development

We use two perspectives (resource-based theory and theory of complementarities) to understand how AES use affects audit process performance. Drawing on resource-based theory, we identify AES as an IT resource and examine how it affects audit process performance through intermediate BPs, specifically internal control processes. Drawing on the theories of complementarities, we examine the complementary roles of 1) CES use in affecting how internal control processes are developed from AES use and how they affect the process performance and 2) accounting managerial competence in affecting the process performance benefits of internal control processes.

Resource-based theory has informed several studies that examine the business value of IT. Early works drawing on the resource-based theory (1) differentiated between IT infrastructure, human IT resources, and IT-enabled intangibles (Bharadwaj 2000); (2) observed that IT resources create value for firms by increasing efficiency and productivity (Barney 1991; Bharadwaj 2000), and (3) concluded that the sustained effective use of IT enables firms to generate benefits that overcome costs (Kohli et al. 2003). However, since IT sources are increasingly ubiquitous and not rare or inimitable, they may not provide sustained competitive advantage and value to firms (Tanriverdi et al. 2010). In particular, due to the broad-scale availability and adoption of standardized information systems like ES, the link between IT

investments and firm-performance has weakened (Chae et al. 2013). Firms therefore constantly seek innovative ways of using IT to improve process performance (Chae et al. 2013; Kohli et al. 2003; Leonardi et al. 2008). Thus, it is no longer a question of whether investing in IT can improve firm performance, but it is a question about how IT capabilities can be combined with non-IT capabilities to generate business value (Karimi et al. 2007b; Kohli et al. 2003). Consequently, studies that examine the business value of IT, and specifically complex systems such as ES, have shifted focus from studying the direct effects of BPs to examining BPs and the technologies that help them technologies generate business value (e.g., see Ayal et al. 2009; Cotteleer et al. 2006; Dorantes et al. 2013).

The process-driven approach of examining process performance outcomes has garnered attention since it shifts focus to a set of *capability-development* considerations that are not addressed by examining the direct link from ES investments to firm performance. First, it focuses attention on how firms that have successfully implemented ES realize benefits. The process-driven approach requires focus not only on benefits from ES implementations but also on how BP capabilities mediate the relationship between ES and benefits (Kohli et al. 2008; Melville et al. 2004). Second, it requires making distinctions among types of BP capabilities that are enabled by ES. This approach enables researchers to examine ES implementation success across a set of BPs with respect to various outcomes (e.g., efficiency, effectiveness and flexibility) (Gattiker et al. 2005; Karimi et al. 2007a).

3.3.1 Capabilities of Internal Control Processes

We contextualize the study to AES and the internal control processes (Table 3.1). Our first step is to identify the internal control processes that are facilitated by AES. We specifically examine AES and capabilities of internal control processes for two reasons. First, internal control processes are the key processes facilitated by AES (Gorka 2012; IFAC-Guidance 2012; Masli et al. 2010). They reflect firms' abilities to manage their financial accounting and reporting structures, achieve effective and efficient operations, and comply with laws and regulations (COSO-Framework 1992; Feng et al. 2009). Large-scale AES investments in public firms were primarily driven by the need to strengthen the internal control quality and comply with SOX (InvestopediaReport 2009). Second, unlike process capabilities that are

subject to varying interpretations and measurement (Barua et al. 1995; Bharadwaj et al. 1999; Mooney et al. 1996), internal control processes are thoroughly tested and their outcomes are publicly reported under Section 404 of SOX.

Table 3.1. Constructs and Operationalization

Constructs/Variables	Corresponding Operationalization
Enterprise system use	Accounting enterprise systems use
Capabilities of internal control processes	Material weaknesses of managerial and operational internal control processes
Audit process performance	• Percentage increase in audit fees • Percentage increase in audit delays

While both Sections 302 and 404 of SOX require MWs to be disclosed, we examine the MWs in internal control processes reported under Section 404. Section 404 requires management to certify the state of its internal control quality. Unlike Section 302, Section 404 requires (1) both the auditors and the firm's management to *independently* test and document the effectiveness of internal control processes, and (2) auditors to provide a separate opinion on the effectiveness of internal control processes. Thus, management thus has less discretion under Section 404 to determine whether or not an internal control deficiency is an MW. Since Section 404 has more stringent requirements than Section 302, prior studies have used Section 404 disclosures (e.g., Ashbaugh-Skaife et al. 2007; Hoitash et al. 2009; Lin et al. 2011).

We first identify the reported MWs under Section 404 and map them to internal control processes. The reported MWs represent the failure of an internal control process activity where there is more than a remote likelihood that a material misstatement cannot be prevented or detected (Lin et al. 2011). As such, MWs provide an objective basis to evaluate the capabilities of internal control processes. This objective measurement overcomes the critique rendered on the capabilities literature of embedded tautologies with performance measures (Rai et al. 2012; Williamson 1999).

Drawing on the literature that examines the internal control processes and BPs, we classify MWs into the following five mutually exclusive and collectively exhaustive categories of internal control

processes: (i) establishment of and compliance to policies and procedures; (ii) erroneous disclosures/filings, restatements and investigations; (iii) design, implementation, and review of internal control processes; and (iv) information technology. The fifth category represents accounting managerial competence.

3.3.2 Existing Classification of Material Weaknesses

There have been different approaches to classifying MWs (see Bedard et al. 2012; Goh 2009; Johnstone et al. 2011). The classification criteria used by prior studies is based on (a) Moody's (2004) suggestion to examine the level at which an MW occurs, and (b) the internal control components suggested in the Committee of Sponsoring Organizations of the Treadway Commission (COSO) framework (1992). Moody's classification categorizes MWs as either account-specific or entity-level. Account-specific MWs occur over specific accounts or transactions whereas entity-level MWs affect the overall financial reporting capability of a firm. While account-specific MWs are identifiable by auditors through substantial testing and are comparatively less severe in magnitude, entity-level MWs are difficult to test and audit and are more severe (Bedard et al. 2012; Goh 2009). In contrast, the COSO framework defines five interrelated internal control components: (a) the control environment, (b) risk assessment, (c) control activities, (d) information and communication, and (e) monitoring. Per the COSO framework *"the five components are derived from the way management runs a business, and are integrated with the management process."* It is important to clarify that the term "management process" used by the COSO framework does not refer to the management practices associated with internal control processes but rather to *how* a firm strengthens its internal control quality.

Studies that use Moody's classification of MWs and the COSO framework of internal control components have examined the role of corporate governance in the remediation of MWs. For example, Goh (2009) examines the role of the audit committee and board of directors in monitoring internal control processes and remediating MWs. Johnstone et al. (2011) examine how remediation of MWs when aligned with changes in governance structures—that is, the board of directors, audit committee, and top management—improve internal control processes. Bedard et al. (2012) examine the variation in the

remediation rates of MWs depending on whether the MWs were reported in account-specific or entity-level activities. Bedard et al. (2012) further suggest that entity-level problems are comparatively difficult to resolve, take longer to remediate, and require large investments in IT and personnel.

In contrast to the above works that have drawn on Moody's classification and the COSO framework to investigate the role of governance structures and financial characteristics in relation to MWs, the objective of this study is to examine the impact of AES on firm performance through the capabilities of internal control processes. As such, our objectives require the classification of MWs in internal control processes according to the type of process. Moody's (2004) and COSO's internal control components are insufficient to identify the correspondence between MWs and business processes for three reasons.

First, Moody's classification suggests that entity-level MWs are more difficult to audit, have greater impact on a firm's ratings, and are difficult to remediate. Bedard et al. (2012), however, find that certain account-specific MWs may be more challenging to remediate than entity-level MWs and can have greater impact than some entity-level MWs. This difference can be partly explained by the fact that firms differ in the operationalization of their internal control processes (COSO-Framework 1992). Depending on the size of a firm, scale of its operations, and level of diversification, a given internal control deficiency can be classified as an account-specific MW for one firm and as an entity-level MW for another. Given the objectives of our study to focus on internal process control capabilities, we require a consistent basis to map MWs to processes.

Second, all MWs are internal control deficiencies but of larger magnitude than a significant deficiency (Ge et al. 2005). When a control deficiency is classified as an MW, it means that even though the MW may be specific to an account or a transaction, it is material for a firm to suggest that its financial statements cannot be relied upon and that a material error may go undetected. As a given BP may result in MWs at the account *and* entity levels, we focus on MWs associated with a process and do not differentiate between MWs at the account and entity levels.

Third, the COSO framework provides guidance—not rules—for firms to establish internal control processes and gives them room to interpret and implement internal control process components differently so that they meet firms' needs (page 4. COSO-Framework 1992). As firms can interpret and operationalize internal control process components differently, we classify MWs according to the business processes to which they belong, where each internal control process provides an abstract of the underlying activities that can be consistently applied to map MWs across firms. We, therefore, use the COSO framework components to guide the categorization of MWs to the extent possible.

3.3.3 Classification of Material Weaknesses into Capabilities for Internal Control Processes

We identified five categories – four process categories and managerial competence – related to internal controls into which we classify the MWs. Drawing upon Davenport and Short (1990) and Benner and Tushman (2003), we identified the internal control process categories that provide a high level abstract using the following approach. First, we used the title and definition provided by Audit Analytics (AA) for each of the 21 different types of MWs to determine the process activities they represents. Second, we classified the process activities into distinct categories depending on their characteristics such that each category represents a BP and consists of process activities that share a common objective. The literature on internal control processes, SOX clauses, and audit and accounting guidance were used as informing sources to identify the internal control process categories. Third, we conducted a structured Q-sorting exercise to ensure the convergent and discriminant validity for the MW categories (Moore et al. 1991). Our six sorters were doctoral students in the accounting department at a major research university. All of them had prior industry experience and knowledge of auditing. Eighty nine percent of the MWs were correctly classified into the categories by the sorters. The results suggest good quality measures. The MW categories, the informing sources, and definitions are shown in Table 3.2. Four of the five categories represent an internal control process and one category represents the accounting managerial competence of a firm. All five categories are elaborated below.

Table 3.2. Material Weakness Classification into Capabilities of Internal Control Processes

Internal Control Processes Category: Material Weakness Classification	Informing Sources	Material Weakness	Full Material Weakness Description
Establishment of and compliance to policies and procedures (Managerial)	COSO-Framework (1992),SOX (2002) Section 302 (4A, 4C, 4D) and 404, Chenhall (2003), Ge and McVay (2005)	Accounting documentation, policy and/or procedure	Represents material weaknesses deriving from internal control systems that do not contain adequate documentation, policies or other means of justifying account balances. These issues may also include failures to ensure that accounts are recorded based on GAAP, SAB, FASB and/or the appropriate accounting methodology is followed. They may also include failures in policies or procedures designed to gather the correct information on a timely basis or problems with the year-end close process. It also includes failures to employ proper procedures over journal entries, non-routine transactions and other common procedural failures.
		Ethical or compliance issues with personnel	Consists of problems with personnel in the areas of compliance with policies, maintenance of ethical standards, fraud and intentional acts that lead to (or could lead to) misstated account balances or financial reports.
		Ineffective regulatory compliance issues	Consists of internal control deficiencies associated with failures to meet regulatory requirements other than taxes.
Erroneous disclosures/filings, restatements and investigations (Managerial)	SOX (2002) Section 302 (5A, 5B, 6), 303 and 404, Wolfe et al. (2009), Rose et al. (2010), Goh and Li (2011), Dechow et al. (2011)	Material and/or numerous auditor/ YE adjustments	Represents circumstances where one of the explanations for a material weakness opinion was the number and/or size of year-end adjustments including those proposed by the auditor. These adjustments also consider footnote and related errors that need to be corrected by the auditor at year-end. Too many, or auditor initiated, year-end adjustments are considered prima facie evidence of a potential material weakness in financial reporting.

Internal Control Processes Category: Material Weakness Classification	Informing Sources	Material Weakness	Full Material Weakness Description
Erroneous disclosures/filings, restatements and investigations (Managerial)	SOX (2002)Section 302 (5A, 5B, 6), 303 and 404, Wolfe et al. (2009), Rose et al. (2010), Goh and Li (2011), Dechow et al. (2011)	SEC or other regulatory investigations and/or inquiries	An SEC or related investigation into company affairs is often evidence of accounting or financial reporting issues that point to internal control deficiencies. This category seeks to identify circumstances where registrants have indicated in their 404 assertion that an SEC investigation or inquiry is underway.
		Restatement of previous 404 disclosures	Represents circumstances where a company has had to restate its 404 opinion because of some event (most likely a restatement of financials) that has occurred subsequent to filing.
		Untimely or inadequate account reconciliations	In reviewing internal control assertions or opinions, it is often the case that inadequate account reconciliations are identified as the reason for material or numerous adjustments. This category seeks to specifically identify such circumstances.
		SAB 108 adjustments noted	This item is checked when the internal control disclosure identifies that a SAB 108, as opposed to a financial restatement, process is used to correct the beginning retained earnings balances associated with previous period accounting errors.
		Management / Board / Audit Committee investigations	Consists of internal control reports indicating that an internal investigation is underway relative to accounting and/or financial reporting matters. This item is demographic in nature.
		Restatement or non-reliance of company filings	Consists of material weakness opinions deriving from problems that led to restatements. Restatements are often evidence of prima-facie internal control deficiencies.

Internal Control Processes Category: Material Weakness Classification	**Informing Sources**	**Material Weakness**	**Full Material Weakness Description**
Design, implementation, and review of internal controls (Operational)	COSO-Framework (1992), SOX (2002) Section 302 (4B, 4C, 4D, 5A), and 404, Abernethy et al. (2004), Ge and McVay (2005), Feng et al. (2009), Li et al. (2012)	Segregations of duties/design of controls (personnel)	This category covers internal control deficiencies associated with the design and use of personnel within an organization. It primarily deals with segregation of duty issues, such as clerks having access to both the cash receipts and the bank reconciliation. It may also deal with more sophisticated design of control issues relating to executives, such as having the ability to change customer records.
		Journal entry control issues	This category is checked whenever the description given by the audit firm or company refers to deficiencies or issues associated with the journal entry process. This category is not checked when there is a journal entry error that originates from control deficiencies in other areas.
		Inadequate disclosure controls (timely, accurate, completeness)	Represents control deficiencies related to the adequacy of information flow that should result in a required disclosure.
		Non-routine transaction control issues	This category is checked whenever a registrant specifically describes one of their control deficiencies as emanating from non-routine types of transactions. These could include acquisitions, asset sales, establishment of new systems and other.
		Treasury control issues	N/A
		Scope (disclaimer of opinion) or other limitations	A material weakness opinion may derive from assertions from the company or auditor that the company had not completed its own review of internal controls and therefore these controls could not be audited. These limitations could come about for any number of reasons.
Information technology (Operational)	Wolfe et al. (2009), Masli et al. (2010), Li et al. (2012)	Information technology, software, security and access issues	Deficiencies in this category include deficient program controls, software programs/implementation, segregation of duties associated with personnel having access to computer accounting or financial reporting records and related problems with oversight/access to electronic data/programs.

Internal Control Processes Category: Material Weakness Classification	Informing Sources	Material Weakness	Full Material Weakness Description
Competence weakness (Accounting managerial competence)	COSO-Framework (1992), Hoitash et al.(2009), Lin et al. (2011), Li et al. (2012)	Accounting personnel resources, competency/ training	Consists of problems with accounting personnel resources, competency, training, experience and/ or adequacy in any way. To meet these criteria, such an indication would have to be contained in the filing or in the remediation plan.
		Ineffective or understaffed audit committee	Represents circumstances where an audit committee may not have the personnel, expert, experience and/or resources to perform their duties to the extent required by Sarbanes Oxley or their charter.
		Senior management competency, tone, reliability issues	This category has been established to identify circumstances where internal control weaknesses are attributed directly to potentially improper or negligent conduct of the current or former senior management of the company. This does not necessarily mean that the assertion is correct, just that such language exists in the filing.
		Insufficient or non-existent internal audit function	Indicates circumstances where a company has stated that its internal audit function was insufficient in identifying and/or advising in the correction of internal control deficiencies. It cannot also identify circumstances where a registrant has identified a failure to have an internal audit department at all, as an internal control failure.

Establishment of and compliance to policies and procedures: MWs classified to this category result from (1) either a lack of internal polices or a lack of compliance to internal policies that ensure that accounts are documented and recorded per standardized (GAAP, SAB etc.) procedures and (2) ethical issues and failure in adhering to regulatory processes.

Referred to as a mechanistic form of governance by Chenhall (2003), the establishment and documentation of policies and procedures is the foundation of a strong internal control environment (COSO-Framework 1992). As SOX Sections 302 and 404 note, it is important that firms (a) determine their internal control policies, (b) formulate procedures and routines that guide personnel to follow the

policies, and (c) document accounts per standard accounting methodologies in order to comply with regulatory laws. Usually attributed to new and financially weak firms, lack of established policies and procedures is the most commonly reported form of MW (Ge et al. 2005). However, in spite of well-established policies and procedures, firms are prone to material errors in their financial statements when rules are bypassed or due to personnel's intentional unethical behavior for personal gain (Leuz et al. 2008). Often classified as entity-level problems (Goh 2009), material errors due to fraud have the most damaging impact on firms' reputations.

Erroneous disclosures/filings, restatements, and investigations: MWs classified to this category include (1) erroneous disclosures and filings of financial and internal control statements and (2) SEC, auditor, and management investigations over financial reporting matters. This category reflects process activities that entail corrections and adjustments to previously issued financial statements, internal control reports, and circumstances that lead to the need for corrections. Since investors' perceptions of investment risk is significantly affected by MW reports (Rose et al. 2010), some firms may project a stronger internal control environment and show themselves to be financially stronger than they actually are. Indeed, some firms try to persuade external auditors to lower their assessment of control deficiencies (Francis et al. 2005; Wolfe et al. 2009). They can also use tactics such as an abnormal reduction in number of employees to improve short-run earnings, maintain/increase investor confidence, and demonstrate competitive success (Dechow et al. 2011). To curtail such behaviors, SOX mandates that firms disclose significant changes in internal control processes or factors that may significantly affect the ability to detect misstatements even after the internal control processes have been evaluated. Sarbanes-Oxley also make it unlawful for any person or party to fraudulently influence, manipulate, coerce or mislead personnel or activities for the purpose of rendering financial statements misleading.

Since the enactment of SOX, several firms have restated their financial statements and internal control reports. The majority of these firms were unable to identify the material errors and problems in their internal control processes in a timely manner (Goh et al. 2011). A firm's internal control assertion is considered unreliable when it is discovered that its accounts are either not reconciled in a timely manner

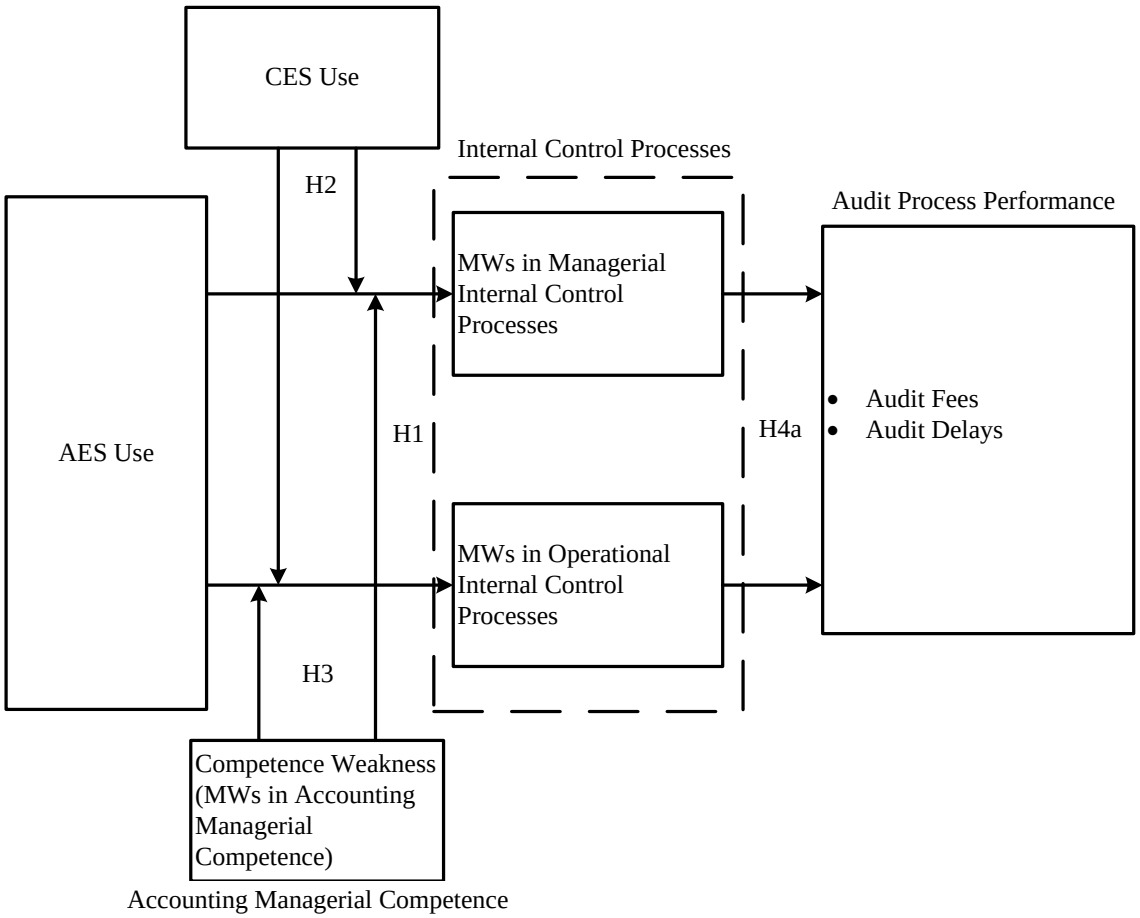
or inadequately reconciled. The auditors under such conditions are mandated to report it as an MW and such firms are required to (a) restate their financial statements and internal control reports and (b) disclose the MWs in the process activities for which previously did not account. The inability of a firm to report internal control issues and material errors discovered after the release of financial statement and an internal control report can lead to internal or SEC investigations. Such investigations are usually initiated when there is sufficient suspicion that extraneous circumstances influenced the accuracy of the disclosed financials.

Design, implementation and review of internal control processes: MWs classified to this category result from poor design, ineffective implementation, and untimely or inaccurate review of controls over process activities that record and report financial data. This category encapsulates MWs associated with process activities for the flow of cash or financial data across business functions within a firm or with a firm's trading partners (Abernethy et al. 2004). Effective design and implementation of internal control processes impact not only the reliability of financial statements and regulatory compliance, but also the efficiency and effectiveness of a firm's operations (COSO-Framework 1992; Feng et al. 2009). The factors that determine the design of internal control processes include the materiality of a process activity over which controls are required, the number of controls required, and the personnel who implement the controls (Feng et al. 2009). Firms are expected to (a) implement adequate controls to ensure the accuracy of information recorded in journals, (b) have sufficient oversight over personnel responsible for handling cash or capable of modifying financial data, and (c) verify that critical non-routine transactions are carried out according to the stipulated laws where experienced and trusted personnel from top management monitor transactions to ensure their fairness and integrity (COSO-Framework 1992; Ge et al. 2005; Li et al. 2012). It is also equally important to review the design and implementation of internal control processes through timely and accurate tests. Despite having well designed and effectively implemented controls, firms cannot rule out the possibility of a material misstatement if the controls are not regularly reviewed. This is why SOX 404 mandates that both management and auditors independently evaluate and attest to the effectiveness of a firm's internal control processes.

Information technology: MWs classified to this category represent inadequate data processing integrity, insufficient system access security, and inappropriate system structure and usage. Research studies and auditing standards underscore the importance of IT for internal control processes as it is essential to ensure the reliability of data, safeguard that the security of sensitive information is not compromised, and improve the efficiency of day-to-day operations (Li et al. 2012). Consequently, IT for internal control quality needs to be effectively designed, implemented and reviewed (Li et al. 2012; Masli et al. 2010; Wolfe et al. 2009). Given the key role of IT processes in internal control processes, firms in their internal control reports identify IT MWs and discuss plans to remediate them. Research studies (e.g., Haislip et al. 2014; Li et al. 2012) have also examined IT controls and IT MWs by differentiating them from other internal control processes and MWs.

Accounting managerial competence: MWs classified to this category arise due to insufficient human and material resources, and/or a lack of accounting skills, training, competence in management, staff, and audit committee to identify and remediate internal control deficiencies. Accounting competence and resources differentiate firms that are able to build strong internal control processes from others that are not (COSO-Framework 1992). This is the only category that entails a firm's human resource capabilities rather than internal control processes as it focuses on the accounting competence of a firm, including strong and capable top management, internal audit function, management board, audit committee members, and accounting/audit personnel of a firm. Prior research suggests that firms with strong accounting competence and resources are less likely to have MWs in their internal control processes. Hoitash et al. (2009) find that board and audit committee characteristics influence the internal control quality of a firm, and firms that have a higher concentration of audit committee members with accounting and supervisory experience have a lower likelihood of disclosing SOX 404 MWs. More education and experience among members in the internal audit function and the resources (infrastructure necessary to implement and test internal control processes, such as technology capabilities, office space) available to accounting, audit and IT personnel also are negatively related to the likelihood of a firm disclosing MWs (Li et al. 2012; Lin et al. 2011).

Our research model shown in Figure 3.1 is grounded in our theory development and is designed to address our research objectives. We now proceed to discuss our hypotheses.



Direct effect of AES use on audit process performance
H4 b: AES → Audit Process Performance
Moderation of AES use on audit process performance direct effect
H4 c: AES Use x CES Use → Audit Process Performance
H4 d: AES Use x Competence Weakness → Audit Process Performance

Figure 3.1 Research Model

3.3.4 Capabilities of Managerial and Operational Internal Control Processes

Managerial BPs in the context of internal control processes are the processes that require human action and judgment where: (i) the firm's management formulates policies and procedures for employees to follow, (ii) management and personnel comply with the policies and procedures, and (iii) management

and auditors investigate and take actions to correct prior errors. All these steps rely on human expertise and intervention. Material weaknesses in managerial BPs arise primarily due to human error, lack of expertise, or intentional bypassing of rules and regulations. Indeed, for these reasons, the detection of errors and remediation of MWs in managerial BPs is difficult (Bedard et al. 2012; COSO-Framework 1992; Hoitash et al. 2009). The use of accounting enterprise systems can assist managerial BPs by facilitating access to necessary information but cannot replace or reduce the need for human judgment and knowledge. Thus, the establishment and compliance with policies and procedures, and erroneous disclosures/filings, restatements and investigations are managerial internal control processes.

In contrast, operational BPs require less human intervention, supervision, and scrutiny than managerial BPs (Zuboff 1988). By virtue of being more easily and extensively digitized, operational BPs generate digital information that can be used to detect errors and rectify MWs. Operational internal control processes that can either be fully digitized or digitized to a large extent include IT, and design, implementation and review of internal control processes. Accounting enterprise systems provide inbuilt capabilities to restrict access to treasury data, segregate duties of personnel, digitize journal entries, enable timely review of internal control processes, and facilitate information flow across the firm to ensure adequate disclosure of internal control processes.

The use of accounting enterprise systems can influence the capability of the managerial and operational internal control processes. The use of these systems can improve the operational internal control processes by extensively digitizing them. The use of accounting enterprise systems can also help improve managerial internal control processes by making critical information easily accessible and facilitating decision-making within a firm. The above arguments lead us to our first hypothesis:

H1: *Increase in AES use will reduce MWs in managerial and operational internal control processes*

3.3.5 Role of Complementary Enterprise Systems

A firm's existing IT capabilities facilitate faster diffusion of new technologies across different business functions (Milgrom et al. 1995; Tanriverdi 2006). A higher proportion of CES use reflects how much a firm emphasizes IT and also indicates prior experience implementing ES. Firms with a higher

level of CES use, by virtue of prior experience with the implementation of information systems, are likely to have better managerial know-how to assimilate new technologies and mature IT project management capabilities (Attewell 1992; Brynjolfsson et al. 2000; Brynjolfsson et al. 1996). Early adopters of technology and firms with pre-existing IT resources, thus, are better able to assimilate newer information systems and realize their benefits (Attewell 1992; Bharadwaj et al. 1999). We, therefore, suggest that the extent of AES use combined with CES use enables firms to combine their AES capabilities with other technologies to redesign and innovate their internal control process activities. Thus, we have the following hypothesis:

> ***H2:*** *The beneficial impacts of AES use in mitigating MWs related to managerial and operational internal control processes are greater for firms with high CES use than for those with low CES use*

3.3.6 Role of Accounting Managerial Competence

Material weaknesses due to a lack of accounting managerial competence negatively affects process performance, raises concerns among investors regarding the costs a firm may have to incur to remediate the MWs, and adds to the sternness with which a firm is negatively evaluated by its stakeholders (Hammersley et al. 2008). It suggests that a firm might have additional errors in its financial statements that might not have been identified and corrected. Specifically, the quality of management and auditors is critical in determining how firms are evaluated by their stakeholders (Hoitash et al. 2009; Krishnan et al. 2007; Krishnan 2005). Disclosing MWs due to a lack of accounting managerial competence in addition to MWs in internal control processes, therefore, reflects poorly on a firm's ability to manage its internal control processes as well as its ability to govern its personnel and maintain strong accounting and audit functions.

When a firm reports MWs due to accounting managerial competence *and* managerial and operational internal control processes, it sends a signal that not only the management of the firm was unable to take proper decisions in regards to the concerned BPs, but also that the firm did not have personnel with the skills, experience, education and resources necessary to maintain internal control

processes and govern the firm to profitability (Hoitash et al. 2009; Lin et al. 2011). Accordingly, we hypothesize:

H3: *Material weaknesses related to accounting managerial competence in firms will diminish the beneficial impacts of AES use in MWs in managerial and operational internal control processes*

3.3.7 Impact of Capabilities of Internal Control Processes and AES Use on Audit Process Performance

Since a key expected benefit of BP digitization is improvement in process performance, we evaluate how AES use, by digitizing internal control processes, leads to better audit process performance, specifically audit fees and delays. Digitization of internal control processes through AES use can help firms improve (a) evaluation and documentation of internal control processes, (b) management and communication of internal control assurance activities, (c) overall risk assessment capabilities, and (d) the tracking of audit process trails (Masli et al. 2010). In particular, the time-cost benefits provided by AES due to these improvements can reduce the required audit effort. These improvements, therefore, are critical for firms to avoid MWs and strengthen the internal control processes. Therefore, COSO (2009a) recognizes technologies such as AES as "control monitoring tools" as well as "process management tools". Thus, digitization of internal control processes is important to reduce MWs and comply with SOX.

When internal control processes are not digitized, it is difficult for firms to audit the trails of errors in financial statements and clearly identify and disclose the causes that led to MWs. When firms are unable diagnose the root cause of errors and provide clear descriptions of the MWs in 10K reports, they are more likely to be penalized by the market in the form of negative stock price reactions (Hammersley et al. 2008). For MWs in managerial internal control processes, firms can find it difficult to collect the accurate information needed to analyze what led to error(s) in decision-making by their personnel. For MWs in operational internal control processes, it can be difficult for firms to identify the stage in the process at which errors occurred. Such problems can lead to expensive and delayed audit cycles to identify and correct for MWs in the internal control processes (Masli et al. 2010). Thus, we hypothesize that:

H4(a): *Material weaknesses in managerial and operational internal control processes will adversely affect audit process performance (increased audit fees and audit delays)*

As previously discussed, AES are focal technology that can improve internal control processes by digitizing them. The automation effect of AES also helps firms improve process performance by facilitating human communications (a) across functional domains and business units, and (b) between internal and external auditors, both of which can be otherwise time consuming and error-prone. For instance, when a manufacturer procures parts, the supply-chain management system can automatically inform the accounts payable and inventory management systems to adjust inventory levels by the number of items approved for purchase, reducing the likelihood of human error in payment and inventory management (Mukhopadhyay and Kekre 2002). The use of accounting enterprise systems also helps eliminate human error in information processing by automatically checking against pre-defined data formats and input parameters (e.g., standard unit measurements for inventory) and providing on-demand exception reports. Dechow and Mouristsen (2005, p.709) provide an illustration in a quote provided by a study company's ("TimeCorp") manager, who comments, "…our people sometimes entered the wrong numbers when counting inventories – you know instead of entering actual value, they accidentally entered their employee ID. Our old systems didn't monitor it. Our SAP [a leading ES vendor] system does." Auditors can leverage these ES capabilities to more effectively and efficiently test the reasonableness of input parameters that affect account valuations (e.g., inventory valuations) and identify outliers/anomalies in transaction data (Alles et al. 2006).

The process performance improvement effect of AES use requires managers and employees to follow system-imposed procedures to manage internal control processes. In other words, when managers and employees perform tasks pertaining to internal control processes by using AES, they follow procedures pre-defined and programmed in the AES. Use of AES helps auditors track tasks performed for internal control processes using data generated by AES. When auditors are able to track tasks, it substantially increases the level of assurance they can place on the accuracy of the information. It reduces the amount of substantive (detailed) testing the auditor must do. Thus, increased AES use will lead to (a)

increased audit efficiency, thereby reducing auditor fees, and (b) improved timeliness of the audit process, thereby reducing audit delays. Drawing on the complementarity logic of AES use with CES use and with accounting managerial competence as previously discussed, we expect the direct effect of AES use on process performance to be amplified with increasing levels of CES use and to be mitigated when there are weaknesses in managerial competence (H4c). Accordingly, we suggest the following hypotheses:

H4(b): *Use of accounting enterprise systems will improve audit process performance (i.e., reduced audit fee and delays)*

H4(c): *Use of complementary enterprise systems will enhance the beneficial impact of AES use on audit process performance*

H4(d): *Material weaknesses in accounting managerial competence will diminish the beneficial impact of AES use on audit process performance*

3.4 Data Collection and Analysis

3.4.1 Panel Dataset Construction

A panel dataset was constructed using data from three sources: (1) *CI Technology Database* (CI), which provided data on AES implementations and use, CES implementations and use, and other IT variables; (2) Audit Analytics (AA), which provided data on internal control processes (MWs), audit fees, and audit delays; and (3) Compustat (CS), which is a source of data on firms' financial variables.

We first collected data on SOX 404 reports from AA. Our initial sample was 62,828 firm-year observations for 16,765 firms for the years 2001 through 2012. We then matched the AA data with data available in CS. This resulted in 45,303 firm-year observations for 8901 firms for the years 2001through 2012 for which CS had corresponding financial metrics data available. We then matched these firm-year observations with data obtained from CI. This exercise produced 6392 firm-year observations for 1651 firms for the years 2003 through 2009 and resulted in a six-year panel data set where the independent variables AES and CES were from 2003 through 2008, while the dependent variables on internal controls and audit performance were from 2004 through 2009. Of the 1651 firms in our sample, 1337 with 4911

firm-year observations had never disclosed any MWs in their internal control processes. In other words, 1337 firms had always had strong internal controls within the period of our study. The remainder 314 firms with 1481 firm-year observations had disclosed MWs at least once between 2004 and 2009, which constitutes the sample for our study.

Table 3.3 Constructs, Definitions, and Measures

Construct/Variable	Variable Name	Definition	Measurement
AES use	AES_Use	Extent of use of an integrated enterprise system for a firm's accounting process	$\sum_{i=1}^{i=N} AES_i/N$ Where N= total number of a firm's sites where each site has at least 50 employees, AES =1 if site *i* uses AES; 0 otherwise
CES use	CES_Use	Extent of use of enterprise systems that are complementary to AES	$[\sum_{i=1}^{i=N} Supply\ chain\ ES_i/N + \sum_{i=1}^{i=N} Customer\ relationship\ ES_i/N + \sum_{i=1}^{i=N} Human\ resource\ ES_i/N + \sum_{i=1}^{i=N} Other\ ES_i/N\ ] / 4$ where each ES use is computed similar to AES_Use
MWs in internal control processes	ICPrWeak	Inability of a firm's internal controls processes to prevent or detect material misstatements in a firm's financial statements in a timely manner	Count of the number of MWs in internal control processes (maximum 17) reported under SOX section 404
MWs in managerial internal control processes	MngPrWeak	Inability of a firm's managerial internal controls processes to prevent or detect material misstatements in a firm's financial statements in a timely manner	Count of the number of MWs in managerial internal control processes (maximum 10) reported under SOX section 404
MWs in operational internal control processes	OprPrWeak	Inability of a firm's operational internal controls processes to prevent or detect material misstatements in a firm's financial statements in a timely manner	Count of the number of MWs in managerial internal control processes (maximum 7) reported under SOX section 404
MWs in accounting managerial competence	CompWeak	Level of knowledge and skills deficiency in accounting-related human expertise	1 if a firm reported an MW due to a lack of accounting managerial competence under SOX section 404; 0 otherwise
Percentage increase in audit fees	FeeIncrease	Increase in the audit fees incurred by a firm as compared to the previous year	Percentage increase in the audit fees from year t-1 to t
Percentage increase in audit delays	DelayIncrease	Increase in the audit delays incurred by a firm as compared to the previous year	The number of days between the audit report date and the fiscal year end. Percentage change from year t-1 to t

Only firms that had MWs were included in our sample so that we could examine how AES use can improve internal control processes by reducing MWs. Given the archival panel structure of our data, it was not possible to measure improvement in the internal control processes for firms that have not had MWs during the given time period of our sample. After the removal of firm-year observations with missing values, our final sample for data analysis was 278 firms with 1237 firm-year observations. As will be discussed later, we used a fixed-effects model to analyze the data. Because we used fixed-effects, the number of firm-year observations varies for each regression analysis depending on the dependent variable being estimated.

The constructs, construct definitions, and measures are shown in Table 3.3. Managerial and operational internal control processes are measured as count variables. Accounting managerial competence, however, is measured as a binary variable, because all the firms that had MWs in accounting managerial competence had the MW "Accounting personnel resources, competency/training". Other accounting managerial competence MWs (less than 20 percent of such cases) appear only in addition to it. The complete distribution and patterns of MWs in our sample can be found in Appendix 3.A.

Control Variables: Following the prior literature (Doyle et al. 2007a; Doyle et al. 2007b; Ge et al. 2005; Li et al. 2012), we included a set of control variables in our models that can affect firms' internal control processes and audit process performance. Firms that face high levels of information risk (likelihood that a firm's financial information pertinent to investor pricing decisions is of poor quality) (Francis et al. 2005)) may not have strong IT capabilities to manage their internal control processes. These firms may be more likely to have material weaknesses in their internal controls (Doyle et al. 2007a). Hence, we control for accruals quality (AccrQual) – a well-established proxy measure for information risk (Dechow et al. 2002; Francis et al. 2005). Large firms are more likely to develop resources and capabilities to establish strong internal control processes and audit process performance. Thus, we include revenue (Revenue) and leverage (Leverage: ratio of liabilities to assets) in our model. Prior studies (Doyle et al. 2007a; Doyle et al. 2007b; Ge et al. 2005; Li et al. 2012) also suggest that loss making firms (Loss: 1 if firm had loss in the fiscal year; 0 otherwise), firms with a large number of

geographical and operational segments (LnSegments: natural logarithm of total number of geographical and operational segments), firms that have foreign operations (Foreign: 1 if a firm had foreign operations; 0 otherwise), and firms that have gone through a merger (Merger: 1 if a firm had a merger in that fiscal year; 0 otherwise) are likely to have MWs in their internal controls. We also include IT capital (ITCapital: [computer capital + 3* IT labor cost]/ total assets (Dewan et al. 2007b)) since firms with large IT capital are likely to have better infrastructure to digitize internal control processes and have better audit performance. Lastly, we include year dummies as controls.

More than 99 percent of the firms in our data had one of the big four auditors. Hence, we did not include it as a control variable. We did not include total assets because of high variance inflation factor (VIF). However, we include several variables (Revenue, Leverage, LnSegments) that address the size of a firm. The mean VIFs for all our models were less than 4. No individual variable had a VIF higher than 8. Table 3.4 shows the descriptive statistics and pairwise correlations. Frequency distribution is shown for the following binary variables: Loss, Foreign, Merger, and CompWeak.

3.4.2 Empirical Specification

Equation 1 is specified to test hypotheses H1, H2 and H3. Equation 2 is specified to test H4 (a, b, c and d). The letter *i* denotes a firm and *t* denotes year. The variables AES_Use and CES_Use were mean centered.

We first conducted a Breusch-Pagan Lagrange Multiplier test to confirm the panel structure of the data. We then conducted a Hausman test that led us to use fixed-effects models. Our data has an unbalanced panel structure. Due to the fixed-effects model, the statistical software dropped data for firms that did not have any "within" variations. Since the dependent variables in equation 1 are count variables, negative binomial regression was used[14]. The analysis was performed using STATA statistical software.

[14] The variance in the dependent variables i.e., MWs in the managerial and operational internal control processes, was four times higher than the mean. We used negative binomial regression over Poisson regression since Poisson regression requires the mean and the variance to be statistically equal. The likelihood ratio test of alpha was highly significant (1% level), suggesting that the variance and mean were not equal, supporting the use of negative binomial regression.

Table 3.4. Descriptive Statistics and Pairwise Correlations

#	Variable	Mean	StDev	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	AccrQual	0.089	0.117														
2	Revenue	1053.75	3678.67	-0.06*													
3	Leverage	0.655	2.039	0.10*	0.02												
4	Loss	0 (70.43%)	1 (29.57%)	0.05	-0.03	0.08*											
5	LnSegments	2.165	0.813	-0.12*	0.10*	-0.05	-0.01										
6	Foreign	0 (42.55%)	1 (57.45%)	-0.09*	0.06*	-0.04	-0.01	0.53*									
7	Merger	0 (53.61%)	1 (43.61%)	-0.05	0.06*	-0.04	-0.11*	0.15*	0.17*								
8	ITCapital	0.025	0.058	0.06*	-0.05*	-0.03	0.01	-0.10*	-0.03	-0.03							
9	AES_Use	0	0.339	-0.03	-0.03	-0.07*	0.01	0.06*	-0.02	0.01	0.05						
10	CES_Use	0	0.212	0.07*	-0.04	0.09*	-0.01	0.03	0.03	0.03	0.06*	0.58*					
11	CompWeak	0 (81.7%)	1 (18.3%)	0.05	-0.02	-0.01	0.09*	-0.01	0.04	-0.01	0.01	-0.06*	-0.05				
12	AES_Use **X** CES_Use	0.042	0.080	0.13*	-0.09*	-0.18*	0.01	-0.08*	-0.06*	-0.08*	-0.01	-0.02	0.24*	0.01			
13	AES_Use ***X*** CompWeak	-0.008	0.144	-0.07*	-0.01	-0.01	0.01	0.04	-0.02	0.04	0.02	0.43*	0.26*	-0.12*	-0.05		
14	FeeIncrease	0.389	1.147	0.05	-0.04	0.13*	-0.04	-0.04	-0.01	-0.01	0.03	-0.13*	-0.03	0.23*	-0.01	-0.08*	
15	DelayIncrease	0.159	0.838	-0.02	-0.02	-0.04	-0.06*	-0.02	0.03	0.01	0.02	-0.07*	-0.02	0.26*	0.02	-0.08*	0.44*
*Significant at 5% level																	

Equation 3-1

$$ICPrWeakS_{i(t+1)} / MngPrWeakS_{i(t+1)} / OprPrWeakS_{i(t+1)} = \beta_0 + \beta_1 AES\_Use_{i(t)} + \beta_2 CES\_Use_{i(t)} + \beta_3 CompWeak_{i(t+1)} + \beta_4 AES\_Use_{i(t)} \boldsymbol{X} CES\_Use_{i(t)} + \beta_5 AES\_Use_{i(t)} \boldsymbol{X} CompWeak_{i(t)} + (Controls)_{i(t)} + (Year\ Dummies) + U_{i(t)}$$

Equation 3-2

$$FeeIncrease_{i(t+1)} / DelayIncrease_{i(t+1)} = \beta_0 + \beta_1 MngPrWeak_{i(t+1)} + \beta_2 OprPrWeak_{ii(t+1)} + \beta_3 AES\_Use_{i(t)} + \beta_4 CES\_Use_{i(t)} + \beta_5 CompWeak_{i(t+1)} + \beta_6 AES\_Use_{i(t)} \boldsymbol{X} CES\_Use_{i(t)} + \beta_7 AES\_Use_{i(t)} \boldsymbol{X} CompWeak_{i(t+1)} + (Controls)_{i(t)} + (Year\ Dummies) + V_{i(t)}$$

3.4.3 Robustness Tests

To ensure the robustness of our findings, we conducted the following analyses: (1) Heckman, (2) difference-in-difference, and (3) binary Logit and Probit. The results from all three analyses were consistent with our results. Given the nature of our data, it is likely that our results could be affected by endogeneity issues. While difference-in-difference, Logit, and Probit analyses were performed to confirm the consistency of the models using different estimation approaches, Heckman analysis was conducted to examine and either rule out or correct for endogeneity issues. Thus, we report only the Heckman analysis findings in Appendix 3.B.

3.4.4 Analysis and Results

The results of the fixed-effects regression for equations 1 and 2 are shown in Tables 3.5 and 3.6. The directions of the control variables are consistent with the prior literature. Hypothesis1 predicted AES use led to a reduction in MWs in managerial and operational internal control processes. Our findings show that with increases in AES use, firms report fewer MWs in managerial internal control processes. However, the coefficient for the AES use is significant at the 10 percent level on a one-tailed test. We could not find evidence that AES use leads to a reduction in MWs in operational internal control processes. Thus, H1 is partially supported.

Hypothesis 2 predicted that CES use will enhance the impact of AES use in reducing MWs in managerial and operational MWs. Findings for H2 show that CES use enhances the impact of AES use on managerial internal control processes, but not for operational internal control processes. When examined collectively for the combined internal control processes, CES use is found to enhance the impact of AES use.

Table 3.5. Negative Binomial Regression Results for Material Weaknesses (H1, H2 and H3)

	All Processes MWs		Managerial processes MWs		Operational processes MWs	
AES_Use ***X*** CES_Use		1.841995 (1.268933)*		1.86165 (1.307809)*		0.5681504 (2.510623)
AES_Use ***X*** CompWeak		1.13353 (0.4341078)***		1.210855 (0.4393116)***		0.5816631 (0.8223274)
AES_Use		-0.4883279 (0.4090474)		-0.6013405 (0.4107188)*		-0.6696314 (0.8992656)
CES_Use		-0.7742901 (0.65303)		-0.3946908 (0.6704778)		-1.241832 (1.36949)
CompWeak		3.144593 (0.1634875)***		3.027571 (0.1651167)***		2.767203 (0.2706933)***
AccrQual	1.828649 (1.067055)**	1.281123 (1.263347)	1.903199 (1.180477)*	1.433402 (1.386928)	5.143847 (2.219401)***	3.919351 (2.53529)*
Revenue	-0.0000316 (0.0000667)	0.0000422 (0.0001206)	-0.0000453 (0.000069)	0.000015 (0.0001269)	0.0005094 (0.0003122)*	0.0000776 (0.0003439)
Leverage	1.426079 (0.3032241)***	0.4898936 (0.3917467)	1.461441 (0.3244319)***	0.4394599 (0.3946708)	1.730363 (0.6156577)***	1.134045 (0.6205264)**
Loss	0.3867948 (0.1382477)***	0.3458788 (0.1414772)***	0.3552558 (0.1397026)***	0.3186315 (0.1452735)**	0.3698686 (0.1977728)**	0.3691025 (0.2107678)**
LnSegments	-0.3482546 (0.1337149)***	-0.2692694 (0.1332316)**	-0.3647121 (0.1406402)***	-0.3199343 (0.1439127)**	-0.3082569 (0.2083136)*	0.0018744 (0.2409163)
Foreign	-0.0759276 (0.1574795)	-0.2545408 (0.1691777)*	-0.087078 (0.1589106)	-0.2621311 (0.1730028)*	-0.1504392 (0.2436526)	-0.0501026 (0.2906312)
ITCapital	-0.4068719 (1.533278)	-0.0517122 (1.627413)	-0.5605377 (1.546238)	-0.4417234 (1.644958)	2.603459 (3.360352)	2.550134 (4.202987)
Merger	0.1574733 (0.1365146)	0.0360728 (0.1409169)	0.1539983 (0.137547)	0.0218624 (0.1447513)	0.3661501 (0.1954217)**	0.1608916 (0.2152708)
Constant	-1.124209 (0.3925533)***	-1.620433 (0.4463547)***	-0.8559309 (0.410565)**	-1.268366 (0.4659583)***	-0.0396213 (0.7404441)	-1.33864 (0.8961804)*
Year Dummies	Included	Included	Included	Included	Included	Included
Firms (Firm-year observations)	251 (1993)	251 (1993)	251 (1194)	252 (1194)	118 (552)	119 (552)
Log likelihood	-834.639	-607.177	-774.324	-563.343	-274.53064	-193.7182

*****p<0.01 ** p<0.05 * p<0.1; one-tailed test given directional effects are hypothesized**

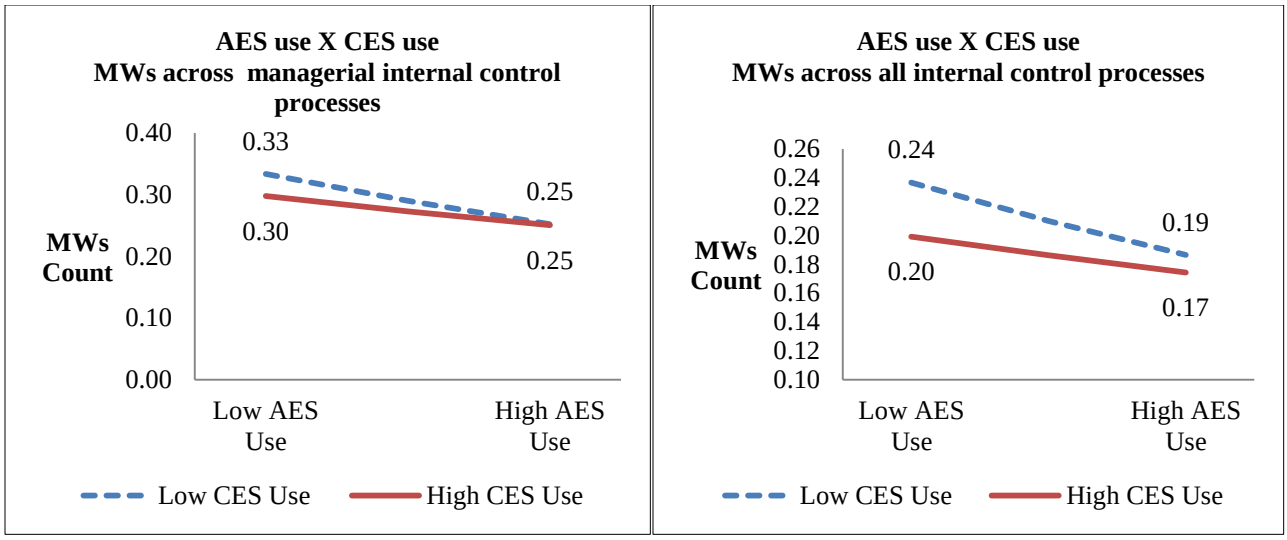


Figure 3.2. Interaction Effects of AES Use X CES Use

The interaction effects of AES use and CES use are shown in Figure 3.2. The graph on the left shows the interaction effect for managerial internal control processes and the graph on the right shows the interaction effects for the combined managerial and operational internal control processes. As evident from the graphs, firms with high CES use have fewer MWs as compared to firms with low CES use. With an increase in AES use, the number of MWs declines for both high and low CES use firms. However, these interaction effects are significant at the 10 percent level on a one-tailed test. Hypothesis 2 is partially supported since the interaction effects of AES use and CES use are not significant for operational internal control processes.

Hypothesis 3 predicted that competence weakness, i.e., MWs due to a lack of accounting managerial competence, mitigates the effectiveness AES use in reducing MWs in managerial and operational internal control processes. Interestingly, we find that competence weakness, instead adversely affects the impact of AES use. In other words, AES use leads to an increase in MWs in managerial internal control processes for firms with a competence weakness. Although the interaction effect of AES use and competence weakness was not significant for operational internal control processes, it was highly significant overall for managerial and operational internal control processes combined. Thus, it can be suggested that use of technology is a complement and not a substitute for managerial competence. Use of accounting enterprise systems leads to worse outcomes for firms that do not have capable accounting and audit personnel, or have an ineffective audit committee and board, or have unreliable top management. Figure 3.3 shows the interaction effect of AES use with competence weakness

for managerial internal control processes on the left and the combined managerial and operational internal control processes on the right. For managerial internal control processes, and for internal control processes as a whole, an increase in AES use results in worse outcomes pertaining to MWs.

Table 3.6 Panel Data Regression Results Testing for H4 (a, b, c, and d)

	Percentage increase in audit fee		Percentage increase in audit delays	
MngPrWeak		0.1237832 (0.0331751)***		0.1625719 (0.0268106)***
OprPrWeak		0.1574115 (0.0624603)***		0.1032756 (0.0505068)**
AES_Use ***X*** CES_Use		0.1906236 (0.8028661)		0.2615435 (0.6497114)
AES_Use ***X*** CompWeak		-0.3202466 (0.2614908)		-0.4392432 (0.2116272)**
AES_Use		-0.1217415 (0.2047219)		-0.0628539 (0.1656593)
CES_Use		-0.4636846 (0.4501636)		0.0243414 (0.3640633)
CompWeak		-0.0789019 (0.1189063)		-0.012782 (0.0962499)
AccrQual	-0.4736786 (0.6892326)	-0.7056829 (0.6777025)	-0.3309093 (0.5721216)	-0.628132 (0.5487729)
Revenue	-0.0001311 (0.0000746)**	-0.0001536 (0.0000733)**	-0.0000723 (0.0000619)	-0.0000991 (0.0000593)**
Leverage	-0.7014407 (0.2651413)***	-0.7848503 (0.2615998)***	-0.3721781 (0.2171437)**	-0.4735231 (0.2090771)**
Loss	-0.0650569 (0.0820517)	-0.0801546 (0.0806099)	-0.1277545 (0.0679081)**	-0.1457376 (0.0650742)**
LnSegments	-0.3135154 (0.1263163)	-0.2831892 (0.1245775)**	-0.2545191 (0.1048246)***	-0.2095873 (0.1008676)**
Foreign	0.0328003 (0.0912499)	0.0226347 (0.0895724)	0.0339559 (0.0755084)	0.028353 (0.0723077)
IT Capital	0.7951194 (0.8844275)	0.8444639 (0.8700964)	0.1741694 (0.7341878)	0.3242913 (0.7046018)
Merger	0.0951932 (0.0801616)	0.0775143 (0.0787788)	-0.0009018 (0.0665487)	-0.027417 (0.0637965)
Constant	3.005869 (0.3397167)***	2.698783 (0.338639)***	1.650257 (0.2801657)***	1.307846 (0.2727675)***
Year Dummies	Included	Included	Included	Included
Firms (Firm-year observations)	277 (1234)	277 (1233)	278 (1237)	278 (1236)
R-Squared	0.2021	0.2219	0.0582	0.1244

*****p<0.01 ** p<0.05 * p<0.1; one-tailed test given directional effects are hypothesized**

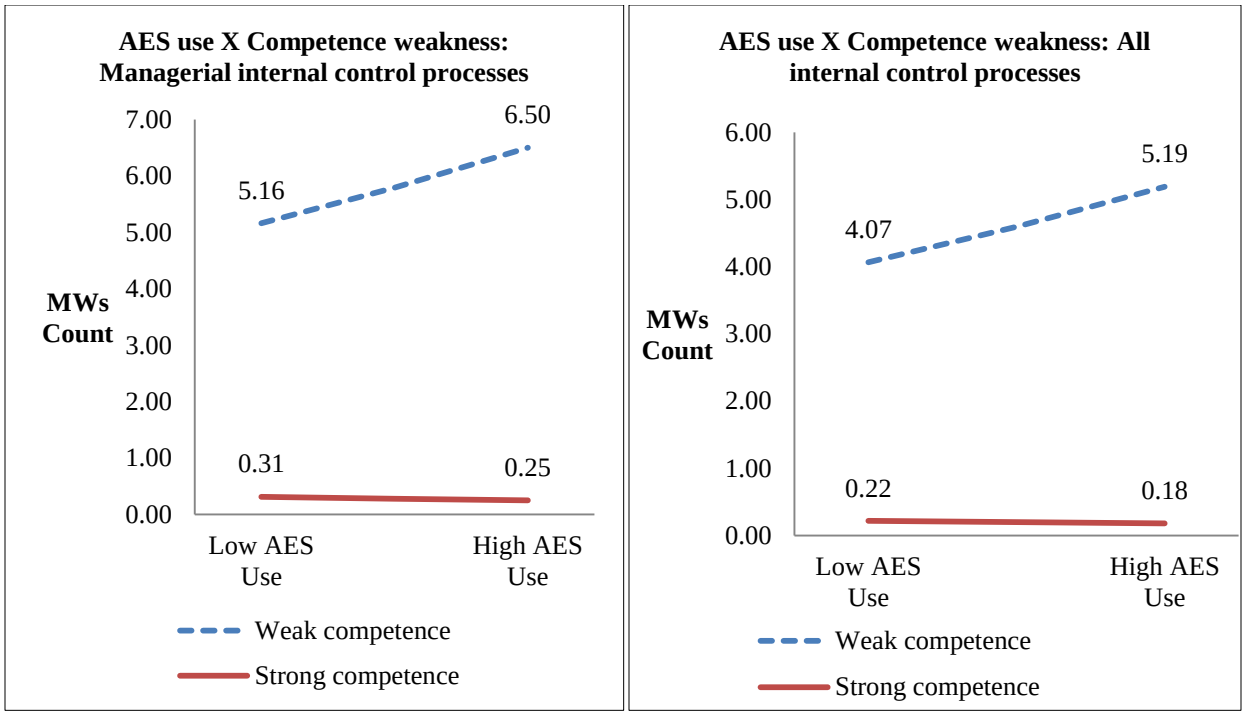


Figure 3.3. Interaction Effects of AES Use X Competence weakness for MWs

Hypothesis 4 examines how managerial and operational internal control processes, and AES use along with CES use and competence weakness, impact audit process performance. Hypothesis 4 (a) predicts that MWs in managerial and operational internal control processes will lead to an increase in audit fees and audit delays. The coefficients for managerial and operational internal control processes for both fee increases and delay increases are positive and significant, suggesting strong support for H4 (a). These findings show that MWs in managerial and operational internal control processes lead to firms to incur higher audit costs. These firms also incur longer delays in releasing audit reports. Thus, it is important for firms to improve internal control processes in order to reduce audit fees and shorten audit delays.

The other three hypotheses H4 (b, c, and d) examine how AES use along with CES use and competence weakness impact audit process performance. Hypothesis 4 (b) predicts that AES use will help firms reduce audit fees and audit delays. Although the coefficients for AES use for both fee and delay increases are negative as predicted, they are non-significant. Hypothesis 4 (b), thus, is not supported since we do not find evidence that AES use directly influences audit fees and delay increases. Hypothesis 4 (c)

evaluates the complementary relationship between AES use and CES use in reducing audit fees and delays. Like the main effects of AES and CES, the coefficients of the interaction effect of AES and CES for fee and delay increases are also non-significant. Hence, H4 (c) is not supported either.

Hypothesis 4 (d) predicts that competence weakness diminishes the impact of AES use in reducing increases in audit fees and delays. The interaction effect of AES use and competence weakness is non-significant for audit fees. We do not find statistical evidence to suggest that AES use and competence weakness together influence an increase in audit fees. For audit delays, however, as shown in Figure 3.4, the results are counter-intuitive to our expectations as discussed in H4 (d). Although, the

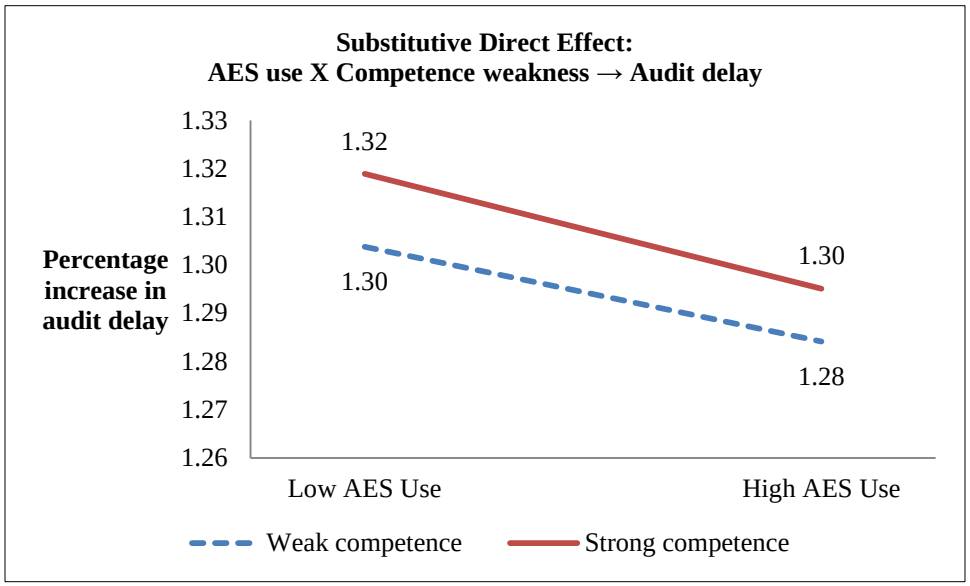


Figure 3.4. Interaction Effect of AES Use X Competence weakness for Audit delay

statistically significant evidence supports the interaction effect of AES use and competence weakness in influencing audit delays, we find that firms with competence weakness, i.e., firms that have MWs in accounting managerial competence, have shorter audit delays as compared to firms that have strong accounting managerial competence. Table 3.7 summarizes the hypotheses and findings.

Table 3.7. Summary of Hypotheses and Findings

Hypothesis		Managerial internal control processes	Operational internal control processes
H1	Increase in AES use will reduce MWs in managerial and operational internal control processes	Supported partially for managerial internal control processes	Not Supported
H2	The beneficial impacts of AES use in mitigating MWs related to managerial and operational internal control processes are greater for firms with high CES use than for those with low CES use	Supported partially for managerial internal control processes	Not Supported
H3	Material weaknesses related to accounting managerial competence in firms will diminish the beneficial impacts of AES use in MWs in managerial and operational internal control processes	Supported. Adverse impact of AES use on managerial internal control processes in the absence of accounting managerial competence	Not Supported
		Percentage increase in audit fee	**Percentage increase in audit delay**
H4 (a)	Material weaknesses in managerial and operational internal control processes will adversely affect audit process performance (increased audit fees and audit delays)	Supported	Supported
H4 (b)	Use of accounting enterprise systems will improve audit process performance (i.e., reduced audit fee and delays)	Not supported	Not supported
H4 (c)	Use of complementary enterprise systems will enhance the beneficial impact of AES use on audit process performance	Not supported	Not supported
H4 (d)	Material weaknesses in accounting managerial competence will diminish the beneficial impact of AES use on audit process performance	Not supported	Opposite results found. Firms with competence weakness have shorter audit delays with increases in AES use

3.4.5 Sobel Mediation Test

We conducted a Sobel mediation test (Baron et al. 1986; COSO 2009b) to examine whether internal control processes mediate the impact of AES use along with CES use and competence weakness on audit process performance. Several studies (e.g., see Kallunki et al. 2011; Mithas et al. 2011; Tallon et al. 2011) have used the Sobel mediation test due to its reliability in assessing the strength of mediation

Table 3.8. Sobel Mediation Test Results

Audit Fees Percentage Increase				
	Managerial Internal Control Processes		**Operational Internal Control Processes**	
	Sobel Test Statistic (One-tailed Significance)	Type of Mediation	Sobel Test Statistic (One-tailed Significance)	Type of Mediation
AES use	-1.36 (0.085)*	Full Mediation	-0.71 (0.235)	No Mediation
CES use	-0.58 (0.28)	No Mediation	-0.85 (0.195)	
AES use ***X*** CES use	1.33 (0.09)*	Full Mediation	0.22 (0.41)	
Competence Weakness	3.66 (0.001)***		2.44 (0.007)***	Full Mediation
AES use ***X*** Competence Weakness	2.21 (0.013)**		0.68 (0.245)	No Mediation
Audit Delays Percentage Increase				
	Managerial Internal Control Processes		**Operational Internal Control Processes**	
	Sobel Test Statistic (One-tailed Significance)	Type of Mediation	Sobel Test Statistic (One-tailed Significance)	Type of Mediation
AES use	-1.42 (0.075)*	Full Mediation	-0.69 (0.24)	No Mediation
CES use	-0.58 (0.275)	No Mediation	-0.83 (0.2)	
AES use ***X*** CES use	1.38 (0.08)*	Full Mediation	0.22 (0.41)	
Competence Weakness	5.74 (0.001)***		2.01 (0.02)**	Full Mediation
AES use ***X*** Competence Weakness	2.5 (0.006)***	Partial Mediation	0.66 (0.25)	No Mediation
*****p<0.01 ** p<0.05 * p<0.1; one-tailed test given directional effects are hypothesized**				

mechanism. The summary of findings from the Sobel mediation test is shown in Table 3.8. Managerial internal control processes fully mediate the impact of AES use and its interaction effect with CES use on audit fees and delays. Although managerial internal control processes fully mediate the impact of the

interaction effect of AES and competence weakness on audit fees, they only partially mediate the impact on audit delays. Operational internal control processes were not found to mediate the impact of interaction effects on audit fees and delays. Although we do not hypothesize the main effects of CES use and competence weakness (i.e., accounting managerial competence), we find that CES use is not mediated by internal control processes. However, the impact of competence weakness is fully mediated by both managerial and operational internal control processes.

3.5 Discussion

3.5.1 Implications for Theory

The key theoretical contribution of the study is that the findings surface the effects, including countervailing ones, through which IT creates business value. We now discuss four key effects and how they extend our understanding of the mechanisms through which IT and related knowledge resources create business value.

First, our findings surface that AES use creates business value through the enablement of business processes, what we term the *technology enablement effect*. While we find AES use improves managerial internal control processes, we do not find AES use improves operational internal control processes as assessed by reductions in MWs. Our results underscore that AES use creates value through informing managerial processes and suggest that mitigating MWs in operational internal control processes is not a value-chain creating mechanism.

Interestingly, we find that the impact of AES use on audit process performance is *fully mediated* by managerial internal control processes. Although both managerial and operational internal control processes were found to affect audit process performance, we find only managerial internal control processes mediate the impact of AES use in reducing audit fees and delays. By considering both managerial and operational internal control processes and surfacing the role of AES in creating business value through the enablement of managerial internal control processes, our study contributes to the prior literature that called for closer examination of intermediate business processes (e.g., Barua et al. 1995;

Rai et al. 1997b; Rai et al. 2006; Ray et al. 2004), and expands our understanding of the process enabled mediators through which IT creates business value.

Second, we find the impact of AES use in strengthening managerial control processes to be amplified by CES use. We also find CES use to enhance the impact of AES use on audit process performance through full mediation by managerial internal control processes. These findings collectively reveal that CES use provides critical information resources from other business domains (e.g., supply chain, customer relationships, human resources) to amplify the positive impacts of AES use on managerial internal control processes and on increases in audit fees and delays. The use of AES and CES moderately correlates in our dataset ($r = 0.58$). This is not surprising as AES and CES are not stand-alone systems and firms are likely to co-develop them, consistent with our findings that AES use and CES use can generate complementarity benefits. To elaborate, CES collect business information from various functional and process domains, which is a critical input resource to AES. Our study suggests that although AES are the focal technology used to improve managerial internal controls and audit process performance, CES also play a complementary role in attaining these improvements, which we term as the *complementarity effect* of supporting technology.

Third, we build on the recent studies (e.g., Mehra et al. 2014; Tambe 2014) that call for emphasizing human capabilities and skill development along with investments in IT. Our findings highlight the importance of accounting managerial competence, and suggest that competence is a key factor in driving improvement in internal control processes. The impact of accounting managerial competence on audit process performance we considered (i.e., increase in audit delay and audit fee) is *fully mediated* through managerial and operational internal control processes. Although AES use was found to show improvements in managerial internal control processes, interestingly, we find that in the absence of accounting managerial competence, i.e., weak competence, AES use adversely affects managerial internal control processes. Thus, our study shows that the benefits of AES use can *only* be derived when a firm has competent and capable (a) accounting and audit personnel, (b) audit committee and audit boards, and (c) top management, which we term as the *knowledge effect*.

Lastly, we extend the findings from prior studies in the accounting and auditing literature that examine the interdependence among the internal control processes, audit process performance, and control monitoring technology (Dorantes et al. 2013; Masli et al. 2010). We find that AES use can reduce audit delays *through* improvement in internal control processes for both strong and weak competence firms. Interestingly, however, we find that the direct (non-mediated) effect of AES use decreasing audit delays to be stronger for those firms that do not have strong accounting managerial competence. That is, firms, with weak competence are likely to emphasize AES use for speed and not for the development of managerial internal control processes. We term this as a *countervailing effect* of AES use. This suggests that although firms with weak competence can demonstrate the benefits of AES use by shortening audit delays, it comes at a heavy cost. Increased AES use for such firms leads to increases in managerial MWs. Thus, the benefits of AES use leading to shorter delays without being leveraged to improve the capabilities of managerial control processes are questionable. Based on these findings, we show that the benefits of AES use when not examined through mediating internal control processes can be misunderstood. It is very important that firms strengthen their accounting managerial competence and not focus only on a process outcome to determine the business value of AES.

3.5.2 Implications for Practice

This study has three key implications for practice. First, we show that firms can create value from ES use though BP capability formation. Firms can innovate BP capabilities by infusing ES functionalities into managerial internal control processes by leveraging IT and business partnerships. In addition, since AES use cannot act as a substitute to improve internal control processes unless firms have strong accounting managerial competence, firms can create value from AES use by complementing AES functionalities with accounting managerial competence to develop managerial internal control processes.

Second, above and beyond developing capable BPs, firms should improve process cycle-times by evaluating activities that can be automated. Improvement in the audit cycle does not equate to improvement in the internal control processes. Instead, firms should focus on the internal control

processes. Improvement in the internal control processes will then lead to improvements in the audit cycle.

Third, firms should establish ES in related process domains and information-exchange interfaces with the systems in those domains. Although ES in related process domains may not directly pertain to internal control processes, effective use of CES in these domains reinforces the effectiveness of AES.

3.5.3 Limitations and Future Research

This study is not without its limitations. We identify four major limitations. First, although our study was based on a rich dataset of internal control processes, we are unable examine how firms that have strong internal controls and managerial competence derive benefits from AES use, nor do we examine the ability of AES use in addressing significant deficiencies. Firms are not required to publicly report or acknowledge significant deficiencies, and thus, due to the limitations of data, we were unable to examine how AES use can reduce significant deficiencies in internal control processes or strengthen existing internal control processes that were not considered to have MWs.

Second, prior studies (e.g., Hoitash et al. 2012; Hoitash et al. 2009; Krishnan et al. 2007; Lin et al. 2011) have called for closer examination of how governance practices of firms influence internal control processes and audit process performance. Accounting, finance and IT governance structures and practices may also influence firms' ability to maintain internal controls. We do not evaluate the role of governance practices in firms. Future research can evaluate the role of governance practices in deriving value from AES use and CES use and building strong accounting managerial competence.

Third, how internal control processes are designed and managed varies from firm to firm and so does the utilization of technology (COSO-Framework 2011). Firms might also have other small scale systems that could be equally effective in designing and maintaining internal control processes. We do not examine such systems. However, since we use fixed-effects models, we only examine within firm variation. Thus, we address this limitation to some extent.

Last, this study focuses on the business value derived from the use of AES by measuring its impact on addressing MWs. The benefits and business value from AES use may not be limited to internal

control processes and audit process performance. There could be other benefits from the use of AES that are not addressed by this study. Researchers can examine other aspects of AES use that might create value for firms at the process and firm levels.

3.6 Conclusion

This study examines how AES use complemented by CES use and accounting managerial competence affects internal control processes and audit process performance. Our findings show that although a focal technology is important in creating business value, it needs critical support from complementary technologies. This study also underpins the importance of domain-specific competence and knowledge in creating value through IT implementation and use. We find accounting managerial competence to be a key driver of improvement in internal control processes, and increased use of technology to have an adverse effect on internal control processes in the absence of strong competence.

We also highlight the importance of examining intermediate BPs rather than only focusing on process performance when examining IT business value. While, there could be improvements in process performance, it can come at a heavy cost if firms (a) do not focus on developing capable personnel and improving competence, and (b) overlook the impact of technology use on the intermediate BPs. Overall, our study contributes to the literature in IT business value, and accounting and auditing.

3.7 Appendix 3.A — Material Weakness Distribution Pattern

Figures 3.5, 3.6 and 3.7 show the distribution patterns of MWs in internal control processes and accounting managerial competence in our sample of firms between the years 2004 and 2009. Accounting documentation, policy and/or procedures were the most common MWs found in the managerial internal control processes. Information technology was the leading cause of MWs in operational internal control processes. Accounting personnel resources, competency and training issues were the most common reasons for MWs due to accounting managerial competence.

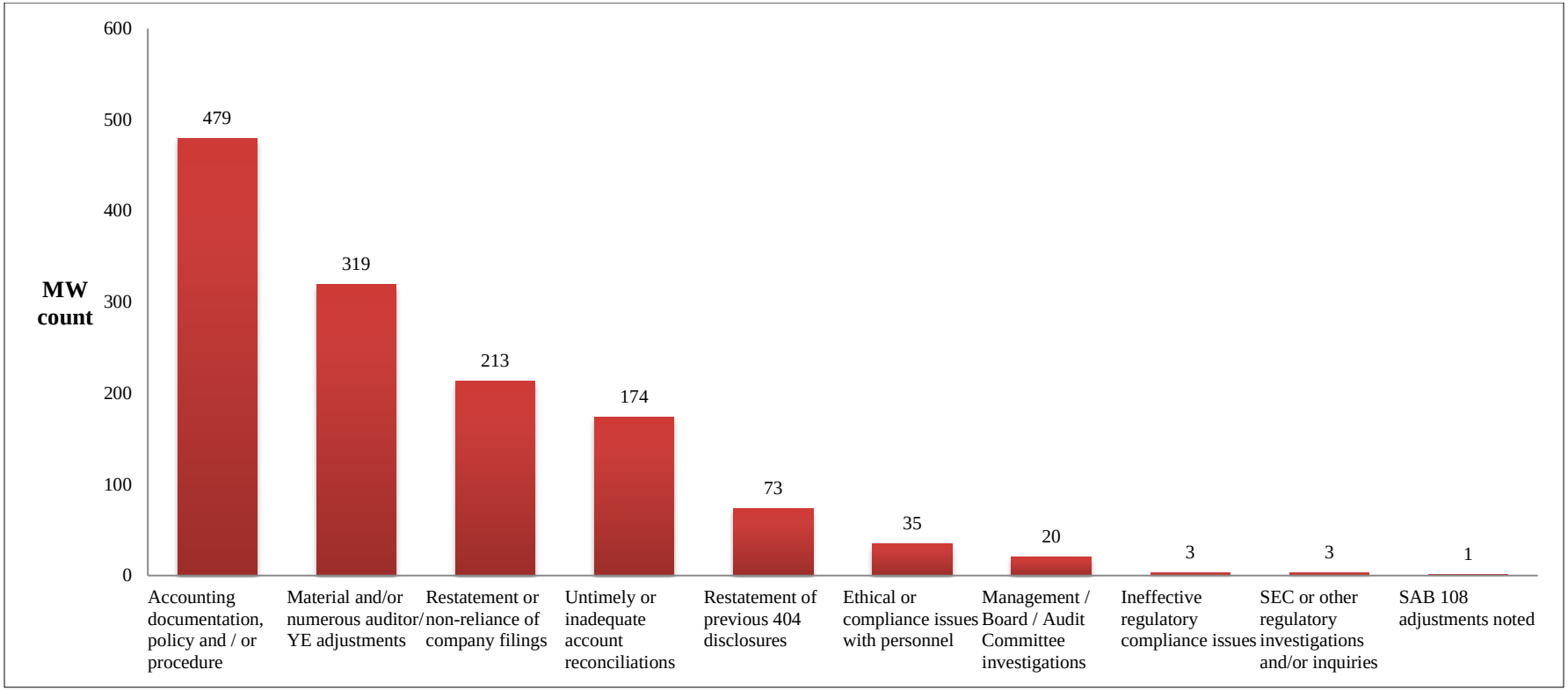


Figure 3.5. Material Weaknesses in Managerial Internal Control Processes

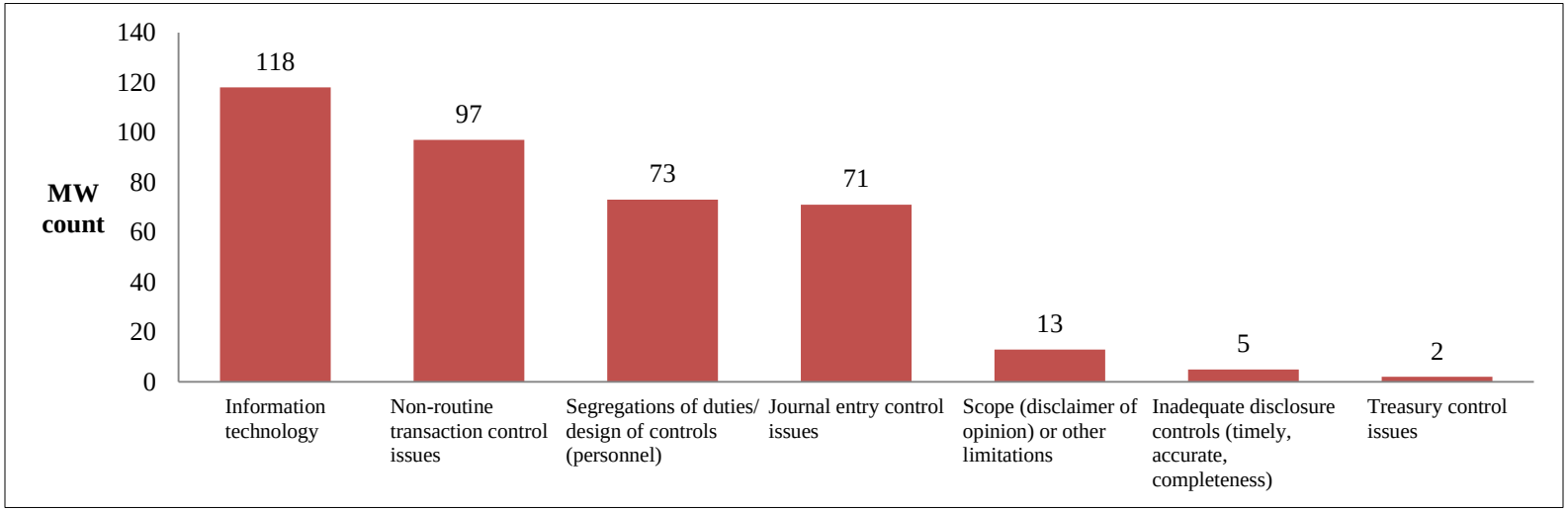


Figure 3.6. Material Weaknesses in Operational Internal Control Processes

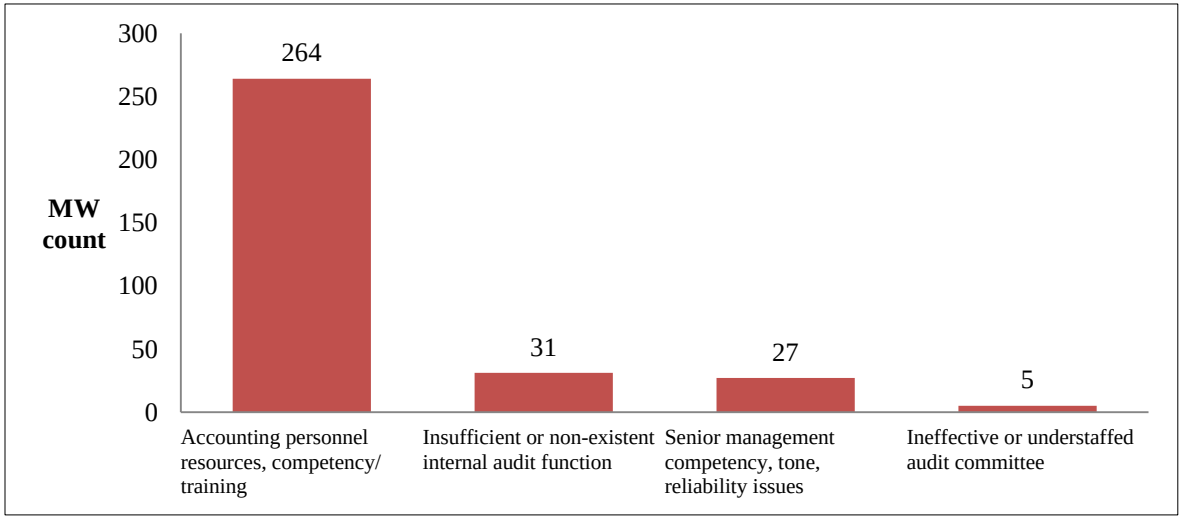


Figure 3.7. Material Weaknesses in Accounting Managerial Competence

3.8 Appendix 3.B — Two-Stage Heckman Analysis

We performed a two-stage Heckman analysis (Heckman 1979) to identify and correct for endogeneity. Our goal was to examine and correct for endogeneity if (a) MWs cause firms to increase AES use and our model suffers from revere causality; (b) other factors affect MWs and AES use, and our model has omitted variable bias issues; and/or (c) firms that use ES are likely not random. Certain firm characteristics may influence ES use, and our model may suffer from self-selection bias. The two-stage Heckman analysis helped us address these issues. We find that the IT budget model developed by Kobelsky et al. (2008) identifies various factors that can affect ES use in firms, and hence we structured the first stage of the Heckman analysis based on this model. We also included a binary variable MaterialWeakness (1 if a firm had an MW in internal control processes; 0 otherwise) in the first stage to address reverse causality.

As recommended by Shaver (1998), we divided our sample into two groups in the first stage of the Heckman analysis for the AES selection model. The first group had firm-year observations for which AES use was above the median value (i.e., high AES use). A new variable AESMedian was created and was coded as 1 (AESMedian=1) for these firm-year observations. The second group had firm-year observations with AES use below the median (i.e., low AES use) and was coded 0 (AESMedian =0). Prior studies have used similar coding schemes to divide their samples (e.g., see Bharadwaj et al. 2007; Hsieh et al. 2011). We estimated a Probit model where the constructs from the Kobelsky et al. (2008) IT budget model and MaterialWeakness were regressed on AESMedian. The descriptions and measurements of the constructs are shown in Table 3.9. Results of the Heckman stage 1 AES selection model are shown in Table 3.10. The dependent variable, i.e., AESMedian, was in the year t+1 and the independent variables were in year t. We then computed the Inverse Mills Ratio and used it as an additional control variable for the second stage of the Heckman analysis.

Table 3.9. Heckman Stage 1 AES Selection Model Constructs and Measures

Construct	Measure
AESMedian	1 if a firm's AES use was above the median value; 0 otherwise
MaterialWeakness	1 if a firm had a material weakness in its internal control process in year t; 0 otherwise
Concentration	Four-firm industry concentration at the four-digit SIC level (Compustat item: SALE)
Uncertainty	Standard deviation of firm i's net income for the previous five years, scaled by sales (Compustat items: IB and SALE)
Rel_Diverse	Related diversification measure for the extent to which firms operate across multiple four-digit SIC code that are within a two-digit SIC code (Dewan et al. 1998) (Compustat item: SALE)
Unrel_Diverse	Unrelated diversification measure for the extent to which firms operate across two-digit SIC codes (Dewan et al. 1998) (Compustat item: SALE)
Profit	Operating income scaled by sales (Compustat items: OIBDP and SALE)
DebtRatio	Long-term debt divided by total assets (Compustat items: DLTT and AT)
AvgSalesGr	Average sales growth of the current and previous years (Compustat item: SALE)
Automate	1 if a firm belongs to automate industries according to Chatterjee et al. (2001) and Anderson et al. (2006); 0 otherwise
Transformate	1 if a firm belongs to transform industries according to Chatterjee et al. (2001) and Anderson et al. (2006); 0 otherwise
HighTech	1 if a firm belongs to a high tech industry according to Francis and Schipper (1999); 0 otherwise
LowTech	1 if a firm belongs to a low tech industry according to Francis and Schipper (1999); 0 otherwise
LogSale	Natural logarithm of sales (Compustat item: SALE).

Table 3.10. Heckman Analysis: Stage 1 Selection Model Results

Probit AES Selection Model	
Dependent Variable →	AESMedian
MaterialWeakness	0.0571537 (0.2717743)
Concentration	-1.01441 (1.569788)
Uncertainty	-0.1106154 (0.9184354)
Rel_Diverse	0.2217253 (1.067462)
Unrel_Diverse	2.086777 (0.8721476)**
Profit	2.460017 (2.256125)
DebtRatio	-1.752316 (1.034966)*
AvgSalesGr	-0.0168008 (1.07771)
Automate	-0.2488001 (0.8630936)
Transformate	-2.30146 (1.186595)**
HighTech	4.90408 (2.204048)**
LowTech	4.020263 (2.05561)**
LogSale	-0.2096769 (0.2617206)
Constant	-1.896128 (2.589099)
Year Dummies	Included
Firms (Firm-year observations)	222 (651)
Log likelihood	-288.900
Wald Chi-Square	27.41
Prob > Chi Square =	0.0371
*****p<0.01 ** p<0.05 * p<0.1; one-tailed test given directional effects are hypothesized**	

In the second stage of the Heckman analysis, we included the Inverse Mills Ratio as an additional control variable to the original models. The results of the Heckman Analysis stage 2 are shown in Table 3.11. The coefficient of the Inverse Mills Ratio was non-significant in all the regression models. Coefficients for all the variables were consistent with our original findings. The results show that our findings did not suffer from endogeneity issues.

Table 3.11. Heckman Analysis: Stage 2 Negative Binomial Regression Results

	All processes MWs	Managerial processes MWs	Operational processes MWs
AES_Use ***X*** CES_Use	0.9439726 (1.493288)	0.7432408 (1.545159)	0.6195074 (2.975531)
AES_Use ***X*** CompWeak	0.8333847 (0.5055426)**	0.8924068 (0.5123292)**	-0.1499978 (1.032033)
AES_Use	-0.3260583 (0.4764617)	-0.381056 (0.4809597)	0.1492827 (1.103902)
CES_Use	-0.7302812 (0.761891)	-0.4081799 (0.7891358)	-1.115412 (1.613947)
CompWeak	3.034046 (0.1860155)***	2.931846 (0.1882902)***	2.714221 (0.3306603)***
Inverse Mills Ratio	-0.2258847 (0.1841918)	-0.1669862 (0.1902912)	-0.551203 (0.3670201)
AccrQual	1.955948 (1.4981)	2.160371 (1.657024)	5.96612 (2.883282)**
Revenue	0.0002053 (0.0001468)	0.0001848 (0.000153)	0.0002451 (0.0003739)
Leverage	0.6899816 (0.4535291)	0.7183808 (0.4545611)	0.9915284 (0.7183629)
Loss	0.3371627 (0.1584142)**	0.3212818 (0.1627438)**	0.325412 (0.2505035)
LnSegments	-0.414143 (0.1775806)***	-0.5087203 (0.1963939)***	-0.160917 (0.3501821)
Foreign	-0.316844 (0.211402)	-0.3340962 (0.2170812)	-0.0501736 (0.3750163)
IT Capital	-0.0143261 (1.654611)	-0.3229444 (1.672279)	0.4730586 (4.735077)
Merger	0.0932301 (0.1617982)	0.0595798 (0.1691274)	0.2580484 (0.2559068)
Constant	-1.198531 (0.5266003)***	-0.8576929 (0.5543818)	-0.6937035 (1.066732)
Year Dummies	Included	Included	Included
Firms (Firm-year observations)	199 (922)	199 (922)	88 (393)
Log Likelihood	-457.26	-420.858	-140.967

*****p<0.01 ** p<0.05 * p<0.1; one-tailed test given directional hypothesized effects**

4 Chapter 4 — Risks and Controls in Internet Enabled Reverse Auctions: Perspectives from Buyers and Suppliers

4.1 Abstract

Internet enabled reverse auctions (RAs) have been touted as a means of making the procurement process more effective and efficient, but as is often the case with information technology (IT), there can be negative consequences about which firms and their managers need to be aware and mitigate. We examine the risk factors that can arise due to the use of RAs. Using the Delphi methodology, we identify both buyer and supplier perspectives on the risk factors associated with the use of RAs. The Delphi study was followed by semi-structured interviews to identify the controls used to address the key risk factors. We find that risk factors map to (1) inadequacy in intangible resources, (2) auction process governance, and (3) interfirm governance (i.e., agency, transaction and relational risk factors). Our findings extend the theory of relationship constraints by recognizing and providing empirical evidence for reverse information asymmetry and principal opportunism as salient risk factors. Last, we find that buyers and suppliers consider input controls to be effective in addressing key risk factors associated with the use of RAs.

Keywords: Reverse Auctions, Risk Factors, Process and Interfirm Governance, Controls

4.2 Introduction

A reverse auction (RA) is a real time, dynamic, procurement mechanism used by a buyer with multiple suppliers. Unlike forward auctions in which buyers compete by increasing the bid price to purchase a product, in RAs suppliers compete by reducing their bid price for products or services, to win the buyer's business. The use of internet enabled RAs (hereafter RAs) emerged in the mid-1990s and has profoundly impacted how firms procure products and services. With about $1.4 trillion[15] worth of goods and services procured electronically worldwide per year, RAs have been found to reduce this cost by 5 to 15 percent (Jap 2003).

The use of RAs requires significant resource investments. Reverse auctions are a part of buyers' and suppliers' long term planning and are *strategically important* for both parties (Fredrickson et al. 1984; Jap 2002). Reverse auctions are important for buyers because they reduce purchasing costs and can provide an efficient means for identifying new suppliers. They are important for suppliers because they can help suppliers expand their business and generate new sources of revenue.

Despite their touted benefits (Jap 2003; Stein et al. 2003), the adoption of RAs has been uneven. Although some firms have been successful with them and have expanded their use (Wyld 2011a), others have either encountered resistance (Peng et al. 2012) or have shunned them due to the long term damage that RAs can have on interfirm relationships (Ruytenbeek 2012). In numerous cases, buyers have not accrued expected savings; suppliers have incurred significant preparatory costs and yet not won a client's business; and both parties have reported the destruction of mutual trust. As a result, the role of RAs as an effective procurement mechanism has been questioned (Charki et al. 2008; Reese 2004).

The apparent paradox of some firms increasing their use of RAs while other firms are discontinuing them motivates our study. Inspired by studies that have examined similar paradoxes (Brynjolfsson 1993; Cameron 1986; Lüscher et al. 2008), we suggest that using RAs is a

[15] http://reverseauctions.gsa.gov/reverseauctions/reverseauctions/

strategically important business decision embedded with risks—defined as the probability of adverse consequences of an outcome (Adebanjo 2010; Baird et al. 1985; Kostamis et al. 2009). A risk is a result of one or more contributing risk factors (Sutton et al. 2008). These risk factors can be addressed through the use of controls. Thus, firms that identify and control the risk factors of RAs are better equipped to realize the benefits of using them. Firms that do not address the risk factors are more likely to suffer losses and are more likely to abandon the use of RAs (Das et al. 2001; Jap 2007; Jemison 1987). Against this backdrop, we suggest that achieving effective use of RAs requires (a) identifying the risk factors associated with using RAs and (b) understanding the controls that mitigate key risk factors.

Prior studies that examine RAs have primarily focused on the benefits and issues from the buyer perspective, while the supplier perspectives and the impact of risk factors on buyers and suppliers use of RAs remain underexplored. To address these gaps, we first use the Delphi methodology to identify the risk factors from both the buyer and supplier perspectives. Drawing on theories of governance, we classify the risk factors into three dimensions: (1) inadequacy in intangible resources, (2) auction process governance, and (3) interfirm governance. We interpret and differentiate between buyers' and suppliers' appraisals of the risk factors in each of these dimensions. We then conduct semi-structured interviews with a subset of Delphi panelists to identify the controls that mitigate the key risk factors. Our study addresses three research questions.

RQ1: What are the risk factors associated with the use of RAs?

RQ2: How do buyers and suppliers differ in their perspectives of the risk factors associated with the use of RAs?

RQ3: What controls can address key risk factors associated with the use of RAs?

4.3 Literature Synthesis of RA Risk Factors

The risk factors discussed in the literature are directed towards the impact of RAs on (1) buyer-supplier relationships, (2) transaction characteristics, and (3) auction design issues. We

categorized the most frequently featured risk factors into these three perspectives and discuss them now.

Buyer-supplier relationships: Prior studies have found that RAs weaken buyer-supplier relationships (Emiliani et al. 2004; Jap 2002; Jap 2007; Smart et al. 2003). Suppliers often regard RAs as a tool that can damage the prospects of a long-term relationship. They consider the use of RAs as a convenient means by which buyers can achieve short-term benefits over suppliers' financial interests, particularly when suppliers are coerced into participating in them (Giampetro et al. 2007). As a result, suppliers are not trustful of buyers who frequently engage in RAs and are reluctant to make any relationship-specific investments (Charki et al. 2008). Hence, in addition to losing suppliers' willingness to make relationship-specific investments, buyers also risks significant damage to their reputation among suppliers (Carter et al. 2004; Elmaghraby 2007; Griffiths 2003).

Transaction characteristics: In the limited time available for suppliers to prepare for RAs, suppliers have to (a) comprehend a buyer's requirements, (b) accurately estimate the cost for providing goods/services, and (c) determine their bid price. If requirements for products/services are not specified correctly and in detail, a buyer and a supplier may have a difficult time negotiating contracts after an RA has been conducted (Beall et al. 2003; Kauffman et al. 2004; Smeltzer et al. 2003). It can also be difficult for a buyer to hold suppliers accountable to the agreed upon price if suppliers were to indicate after the RA that the offered bid price pertained to specifications that do not correspond to the buyer's *actual* requirements.

When suppliers win business from a buyer after offering low bid prices in an RA, they may compromise on the quality of products and services in order to recover their profit margin. Suppliers can even retaliate against the buyer by either over charging or by refusing to accommodate any changes in post-contract specifications (Emiliani et al. 2004; Jap 2007). Although it may not be feasible to recognize all possible post-contract contingencies, the transaction cost theory (Williamson 1979) emphasizes drafting an optimal contract where both

buyer and suppliers put forward as many concerns and conditions they can, to address price issues pertaining to quality and delivery of products and services.

However, a buyer faces risk factors prior to the contract as well. When using RAs for innovative products or products of strategic importance, buyers have reported concerns regarding suppliers sharing sensitive information about the buyer with the buyer's competitors (Charki et al. 2008). Suppliers may also form cartels and collude to control the price, especially when the buyer uses RAs with a relatively small base of suppliers (Carter et al. 2004; Emiliani 2005; Emiliani et al. 2002; Talluri et al. 2004). It is, therefore, important for the buyer to assess the market by examining the number of viable suppliers available and the current supply and demand. Unless all the conditions are favorable, the buyer is not likely to be able to generate competition in the RAs (Smeltzer et al. 2003). Unfavorable market conditions and lack of competition can result in the failure of an RA, thus resulting in wasted preparation and expenses (Beall et al. 2003; Kauffman et al. 2004).

Auction design issues: When planning for an RA, the products and services that are auctioned by a buyer are usually partitioned into lots. A different number of suppliers may compete for each lot. It is incumbent upon the buyer to design lots that maximize the number of competing suppliers. If a lot is too large, competent but smaller suppliers will not be able to compete against large suppliers. On the other hand, large suppliers may not be willing to invest in smaller lots (Smeltzer et al. 2003). The buyer, therefore, will be unable to effectively utilize the RA if it does not structure lots effectively and identify suitable suppliers to bid on them.

While it is important to consider the capability of suppliers when designing lots, it is equally important to account for suppliers' competencies. Often, due to the way RAs are designed, innovative and cost-efficient suppliers do not get the opportunity to differentiate themselves (Smart et al. 2003). When suppliers' non-price attributes are ignored, the offered bid price becomes the primary focus and auctioned products and services are treated as commodities. When products and services with non-price attributes are treated as commodities, the buyer loses

out on the opportunity to gain better business partners and can also end up incurring higher overall costs.

For suppliers, alternatively, the auction design issues correspond to formulating and adhering to their bidding strategies. When award terms are not communicated, suppliers tend to assume that the lowest bidder will be awarded the business. This assumption can lead to aggressive bidding in an RA. Suppliers who do not fix their lowest bid price may get carried away in the frenzy of competition and bid beyond their means — a phenomenon known as auction fever. Such suppliers may later find it difficult to honor their bid price. Since suppliers are expected to abide by their offered auction price, they cannot later adjust a bid that was deemed to be too low (Jap 2002; Smart et al. 2003; Smeltzer et al. 2003).

Gaps in the literature: While past work has identified some risk factors associated with the use of RAs, there has been no systematic effort to identify and examine these risk factors. Only a handful of RA risk factors have been identified thus far and the literature lacks comprehensive guidance on the important risk factors as perceived by buyers and suppliers and effective methods to mitigate them. There are three critical gaps that need to be addressed. First, the literature does not explore the differences in the perceptions of risk factor between buyers and suppliers and therefore falls short of providing a theoretical explanation for perceptual differences that may exist. Second, the theoretical interpretation of RA risk factors remains underexplored. Last, prior studies do not identify risk mitigation strategies that firms can use to address risk factors. To address these gaps we first conduct a Delphi study with buyer and supplier panels and develop two lists of top-ranked risk factors —one for each panel. Drawing on agency theory, we characterize a buyer as a principal and the supplier as an agent to theorize the difference in their perception of risk associated with an RA. We categorize the identified risk factors based on (1) inadequacy in intangible resources, (2) auction process governance, and (3) interfirm governance (agency theory, transaction cost theory, and relational theory) to theoretically interpret the risk

factors. Finally, using semi-structured qualitative interviews we identify the controls that can be used to mitigate the key risk factors.

4.4 Data Collection and Methodology

4.4.1 Delphi Study

Developing a comprehensive list of risks factors requires participants with expertise in the field of sourcing and procurement to identify buyer risk factors, and with expertise in business development, sales and marketing to identify supplier risk factors. Considering the exploratory nature of the research questions, the ranking-type Delphi methodology seemed to be the most appropriate choice. The Delphi methodology was developed by the RAND Corporation in the 1950s to (a) define important issues, (b) elicit opinions from a panel of experts through iterative controlled feedback, and (c) reach consensus among the experts on the panel. It has since been widely used in studies that have sought the aid of domain experts to identify issues and reach consensus on relative importance (e.g., Heminger et al. 2005; Liu et al. 2010; Schmidt et al. 2001). For this study, two separate Delphi panels were formed, one comprised of buyers and the other comprised of suppliers. Figure 4.1 shows the three phases of the Delphi methodology procedure.

Composition of the panels: Delphi studies require focused and committed participation over a period of time and typically do not have more than 25 participants on a panel. We, therefore, stopped recruiting panel members once we obtained participation commitment from 35 panelists for each panel, as this would provide ample margin for some attrition, which invariably occurs in studies of this nature. To ensure reliable and valid data, we included a diverse group of experts with years of experience in procurement and RAs for the buyer panel. Similarly, for the supplier panel, we recruited professionals with rich experience in sales, business development, and marketing who had experience both in RA bidding as well as in post-auction negotiation. We recruited the panelists using professional connections from the Institute of Supply Management

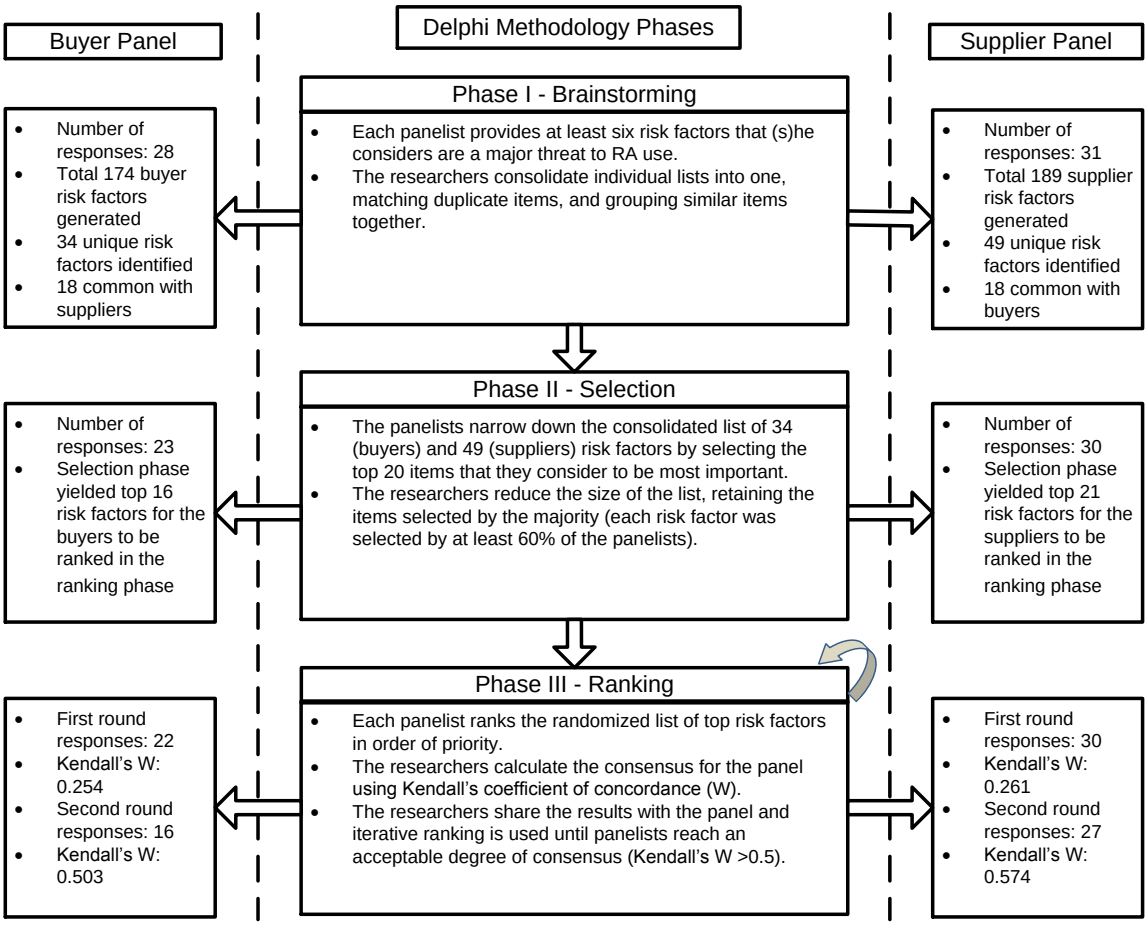


Figure 4.1. Delphi Methodology

(ISM). The industries represented in both panels include retail, IT, utilities, manufacturing, hospitality and healthcare. Table 4.1 shows the profile of both panels.

Platform for the Delphi Study: The Delphi study was conducted asynchronously over the Internet due to the impracticality of bringing the panelists together for successive rounds of face-to-face meetings, since they resided in a variety of different locations around the world. We created a web-based interface using the Visual C# programming language and SQL Server 2008 database. Similar electronic instruments have been shown to provide various benefits that include faster data collection and processing of results (Singh et al. 2009). A web-link of the website was sent to the panelists who were given two weeks to respond in each phase.

Phase I (Brainstorming): We initiated the brainstorming phase by requesting panelists to provide at least six items that s/he considered to be serious risk factors when using RAs. The objective of asking for six or more risk factors in the first phase was to not make the process too time consuming and yet achieve reasonable coverage of the domain. This was an open ended solicitation of ideas (Okoli et al. 2004; Schmidt et al. 2001). Each panelist in both panels was asked to provide a brief description of each item that s/he supplied.

These descriptions helped us to (1) understand the risk factors, and (2) remove duplicates by consolidating items with the same underlying meaning. We also required panelists to answer a questionnaire that provided us with some basic demographic information, their experience with RAs, and their firm's involvement in RAs. In Phase 1, 28 experts from the buyer panel and 31 experts from the supplier panel responded. The buyer panel provided a list of 174 risk factors and the supplier panel provided a list of 189 risk factors. The four researchers then worked together iteratively to consolidate and refine the list by grouping similar items together, removing duplicates, and sharpening descriptions to improve clarity. This process yielded a consolidated list of 34 unique risk factors for the buyer panel and 49 unique risk factors for the supplier panel. In all, 65 unique risk factors were identified, of which 18 were common to both panels.

Phase II (Selection): We sought to narrow the consolidated list into a more manageable set for the ranking phase. Following Schmidt's (2001) suggestion, we asked each panelist to select his/her top 20 risk factors (i.e., those that represented the most serious impediments when participating in/using RAs) from the unrated list of 49 (supplier)/34 (buyer) risk factors from Phase 1. After reviewing the selection of top 20 risk factors from each respondent on each of the panels, we retained only those items that were selected by a significant majority of the panel; specifically items selected by 60 percent of panelists, as this gave us a target range of 15-25 items for the subsequent ranking phase. A range of 15-25 items is ideal because anything less than 15 risk factors to rank would not have let us identify the common top risk factors between the two panels, and anything more than 25 risk factors to rank would have been excessively cumbersome

for the panelists. With this selection process, the initial lists of 34 buyer risk factors and 49 supplier risk factors were reduced to 16 and 21 respectively.

Table 4.1. Profile of Delphi Study Panels

Demographic Variable		**Buyer Panel**	**Supplier Panel**
Panel size		28	31
Average overall work experience		19 years [Range 4-45]	20 years [Range 4-40]
Average experience in sourcing (buyers), sales/business development (suppliers)		15 years [Range 3-45]	15 years [Range 4-40]
Number of RAs participated in (Buyer panel range 4-550) (Supplier panel range (5-4500)	0 to 5	14%	29%
	6 to 10	0%	29%
	11 to 20	18%	0%
	21 to 50	21%	32%
	51 to 100	11%	0%
	101 or more	36%	10%
Will participate in reverse auctions in future?	Yes	96%	79%
	No	4%	21%
Average number of employees in their sourcing/procurement department (buyers), sales/business development department (suppliers)		75	58
Average number of years since their firm has been using RAs		5.4 years	6 years

Phase III (Ranking): This phase entailed the buyer panel ranking the top 16 risk factors and the supplier panel ranking the top 21 risk factors determined in Phase 2. Each panelist was asked to rank the risk factor that they consider the most important as first, and so on. Following Schmidt (2001), we used Kendall's coefficient of concordance (W) to measure the degree of consensus in the panel. The value of W can range from 0 to 1, with 0 indicating no consensus and 1 indicating a perfect consensus. A Kendall's W less than 0.50 indicates low consensus, 0.50 to 0.70 indicates moderate consensus, and greater than 0.70 indicates strong consensus.

We conducted two rounds of ranking. Twenty-two panelists for the buyer panel and 30 panelists for the supplier panel responded in the first round of ranking. For the buyer panel, 16 panelists responded in the second ranking round, yielding a Kendall's W of 0.503. For the supplier panel 27 panelists responded, yielding a Kendall's W of 0.574. The Kendall's W of more

Table 4.2. Summary of Data Collection

Step	Methodology	Data Collection Description	Buyer	Supplier
Step 1	Delphi Study to identify RA risk factors	Total number of risk factors identified (raw data)	174	189
		Number of unique risk factors identified in Delphi Study Phase 1	34	49
		Number of risk factors discussed: Top ranked risk factors from Delphi Study Phase 3	16	21
Step 2	Semi-structured interviews to identify controls for key risk factors	Number of key risk factors on which panelists were interviewed to identify controls	Top 5 buyer risk factors + common risk factors in the top ranked list of the buyer panel (total 11 risk factors)	Top 5 supplier risk factors + common risk factors in the top ranked list of the supplier panel (total 11 risk factors)

than 0.5 suggested that a moderate level of consensus had been reached for each of the panels, and that we could have a reasonable degree of confidence in the rankings. Following Schmidt's (2001) recommendation, we stopped the ranking process at this point, since the coefficient of concordance indicated a reasonable level of consensus had been reached. While we considered a third round of ranking to see if the consensus would improve further, we ultimately decided against it as we were starting to see some attrition, indicating that panelists were becoming weary of the process.

4.4.2 Follow-up Interviews for Controls Identification

In order to gain in-depth understanding of the controls to address the key risk factors identified in the Delphi study, we conducted semi-structured interviews with a smaller focused group of panelists. We identified key risk factors based on (1) those in the top five risk factors of

each panel, and (2) the common risk factors featured in the top ranked list of the combined panels.

Ten experts from each panel were invited for interviews, of which seven from each panel agreed to participate. The average work experience of the interviewees was 26 years (range 12-40) for the buyer panel and 28 years (range 12-43) for the supplier panel. The average number of RAs conducted by the interviewees from the buyer panel was 193 (range 50-550). Suppliers, on average, had participated in 1030 RAs (range 500-4000). The summary of data collection for the Delphi study and the follow-up interviews is shown in Table 4.2.

4.5 Results and Discussion

4.5.1 Classification of Risk Factors

Drawing on theories of intrafirm governance, auction process governance, and interfirm governance, we classified the risk factors identified in our study into theoretical dimensions and sub-dimensions that are mutually exclusive and yet collectively exhaustive. Three dimensions and 11 sub-dimensions were identified. The dimensions represent broad governance concepts pertaining to one or more theories. The sub-dimensions represent constructs of the informing theories. The dimensions of risk factors are: (i) inadequacy in intangible resources, (ii) auction process governance, and (iii) interfirm governance, i.e., agency, transaction and relational risk factors. Examples of sub-dimensions include the phases of auction process governance (i.e., pre, during and post-auction phases) and the constructs of interfirm governance (i.e., opportunism, contractual hazards, etc.).

We relied on the combination of risk factor title, description, and raw data (collected during the first phase of the Delphi study) to map risk factors to the dimensions and sub-dimensions. First, an elaborate list of dimensions and sub-dimensions to which risk factors could be mapped was developed from the intrafirm governance, reverse auctions, interfirm governance, and IS literatures. Second, the mapped dimensions and sub-dimensions were retained

Table 4.3. Reverse Auctions Risk Factors

Theoretical Dimension	Sources	Sub-dimension	Risk Factor	Buyer /Supplier	Buyer Rank	Supplier Rank
1. Inadequacy in Intangible Resources	Bakos (1997; 1998), Hur et al. (2006), Rai et al. (2009), Teo et al. (2009)	1.1 Adoption of Mechanism	1.1.1 Lack of top management support	Common	6	NR
			1.1.2 Resistance by internal clients within buying organization to reverse auction procedures and outcomes	Buyer	5	NA
			1.1.3 Suppliers lack adequate knowledge of reverse auction process	Common	16	NR
2. Auction Process Governance	Jap (2002; 2003), Beall et al. (2003), Engelbrecth-Wiggans et al.(2006), Elmaghraby (2007), Jap (2007), Mithas and Jones (2007), Charki (2008), Aloini et al. (2012)	2.1 Pre-Auction	2.1.1 Inadequate supplier qualification	Common	3	6
			2.1.2 Improper lot structuring	Buyer	9	NA
			2.1.3 Award terms not clearly communicated prior to auctions	Common	7	NR
			2.1.4 Reluctance of suppliers to participate	Buyer	8	NA
			2.1.5 Communication barriers create ambiguity regarding buyers' requirements	Supplier	NA	9
		2.2 During-Auction	2.2.1 Impulsive bidding leads to unrealistically low bids	Supplier	NA	12
			2.2.2 The risk of other suppliers not adhering to the specifications and underbidding	Supplier	NA	2
			2.2.3 Early attrition of quality suppliers due to aggressive bidding	Supplier	NA	15
		2.3 Post-Auction	2.3.1 Suppliers unable to maintain their offered auction price	Common	NR	13
		2.4 Phase-Independent	2.4.1 Reduced profit margin	Supplier	NA	8
			2.4.2 Commoditizing innovative products/services	Supplier	NA	10
			2.4.3 Omission of non-price criteria limits buyer’s understanding of suppliers’ full capabilities.	Common	10	16
			2.4.4 Singular focus on price does not factor in total cost of ownership	Common	2	19
			2.4.5 Lack of awareness of who you are competing with and their cost structures	Supplier	NA	18

3. Interfirm Governance	Williamson (1991), Anderson and Dekker (2005b)	3.1 Contractual Hazards	3.1.1 Inadequately specified requirements	Common	1	5
	Williamson (1991), Bakos and Brynjolfsson (1993)	3.2 Small Number Bargaining	3.2.1 Market conditions not conducive for reverse auctions	Buyer	12	NA
			3.2.2 Adverse long-term impact on supply base	Common	NR	17
			3.2.3 Lack of competition in the auction	Buyer	4	NA
	Eisenhardt (1989b), Sharma (1997), Dawson et al. (2010)	3.3 Information Asymmetry/Reverse	3.3.1 Illusion that supplier needs to offer the lowest price to be awarded the business	Supplier	NA	14
	Dawson et al. (2010), Miller and Sardais (2011), Hawkins et al. (2013)	3.4 Opportunism (Including Goal Incongruence and Self-Interest)/ Agent Opportunism	3.4.1 A competing supplier may bid low to gain the contract and then raises prices once the buyer is locked in	Supplier	NA	21
			3.4.2 Quality of the product could be reduced by suppliers to achieve offered price	Common	NR	1
			3.4.3 Quality of service and support could be reduced by suppliers to achieve offered price	Common	13	3
	Eisenhardt (1989b), Sharma (1997), Poppo and Zenger (1998), Dahlstrom and Nygaard (1999), Madhok et al. (2006)	3.5 Opportunism (Including Goal Incongruence and Self-Interest)/Principal Opportunism	3.5.1 The risk of buyer manipulating the auction by introducing artificially low bids	Supplier	NA	7
			3.5.2 Buyers create distrust when they use reverse auctions to test the market with no intention of buying	Supplier	NA	20
			3.5.3 Inclusion of suppliers who will not be awarded the business	Buyer	15	NA
			3.5.4 Buyer not faithful to the auction process	Common	11	NR
			3.5.5 Failure to honor award terms deters future supplier participation	Buyer	14	NA
	Dyer and Singh (1998), Camuffo (2007), Mithas et al. (2008), Klein and Rai (2009)	3.6 Relational Risk Factors (Interaction-based Non-contractiblity)	3.6.1 No opportunity for relationship building	Supplier	NA	4
			3.6.2 Weakens existing strategic relationships with suppliers	Common	NR	11
NR: Risk factor was identified by the panel but was not selected to be among the top ranked risk factors						
NA: Panel did not identify the risk factor						

and the unmapped dimensions and sub-dimensions ones were discarded. During this process, a few risk factors were found to be counter-intuitive to the known constructs of governance – specifically the constructs of agency theory. We devised two new sub-dimensions to maps these risk factors. The new sub-dimensions are (a) reverse information asymmetry and (b) principal opportunism (Hawkins et al. 2013). Although alluded to by the theory of relationship constraints (Dawson et al. 2010), and other studies (Hawkins et al. 2013; Joshi et al. 1997; Wyld 2011b) the empirical evidence for these counter-intuitive risk factors has been insufficient.

The dimensions, sub-dimensions, informing sources, corresponding top ranked risk factors from the third phase of the Delphi study, the buyer/supplier panel that identified a risk factor, and the ranks of the risk factors are shown in Table 4.3. For brevity and focus, only the top ranked risk factors for both panels from the third phase (as shown in Table 4.3) are discussed. We discuss the dimensions, sub-dimensions and the associated risk factors. The complete list of risk factors and the sub-dimensions is shown in Appendix 4.A[16].

4.5.2 Dimension 1: Inadequacy in Intangible Resources Risk Factors

This dimension encompasses the risk factors that entail organization-wide adoption and management of RAs. One sub-dimension and three risk factors were mapped to this dimension. The first two risk factors pertain to the adoption and acceptance of RAs as a new mechanism. The third risk factor pertains to the adoption of technology and skills necessary to use RAs.

While studies have emphasized the importance of top management support for procurement innovations and success (Rai et al. 2009), the impact of the absence of this support is also implicit in their findings. Our findings suggest that a lack of top management support *(1.1.1)* either restricts the use of RAs or prevents the enforcement of their outcome. Likewise, internal

[16] Appendix 4.A also lists the corresponding actual risks. A risk is defined in this paper as a possible negative consequence of an undesired outcome resulting from an action or an event. Risk factors identified in this study are the factors that constitute these risks. One or more risk factors, therefore, lead to a specific risk (e.g., lack of top management support and resistance by internal clients within a buying organization are risk factors that lead to the risk of a buyer's inability to enforce the outcome of an RA). Since the objective of this paper is to identify and theoretically interpret the risk factors and the subsequent controls, our discussion of risk factors is organized according to their theoretical dimensions as shown in Table 2.

clients also play an important role. Internal clients frequently interact with suppliers and establish business relationships. They can oppose the transition of business to new suppliers. Resistance by internal clients *(1.1.2)* can either prevent the use of RAs upfront or block the award of business.

A third risk factor pertaining to the inadequacy in intangible resources for RAs is suppliers' lack of adequate knowledge about the reverse auction process *(1.1.3)*. Such a lack of knowledge can relate to the adoption of the technology needed to conduct RAs and the skills necessary to use RAs, both of which require a firm to enhance its IT capability. Participating in RAs can be particularly problematic for suppliers who have no prior experience using the relevant technology. Without training suppliers to use the technology and explaining to them the role of RAs in the procurement process, a buyer faces failure of the RA process. Thus, suppliers' lack of knowledge of the RA process and procedures hinders a buyer's ability to extract the benefits of RAs.

4.5.3 Dimension 2: Auction Process Governance Risk Factors

This dimension entails design and implementation of an RA. Four sub-dimensions and 14 risk factors were mapped to this dimension. Since the use of RAs entails a methodical process of planning an RA (prior to the RA event), executing the RA (managing the RA event), and post-auction negotiations, each step in RA-driven procurement is a temporal sequence of phases that require effective governance. Drawing on process engineering research (e.g., see Davenport 2005; Davenport et al. 2003) the sub-dimensions are examined according to the phase of the RA process in which they occur.[17] Thus, the identified auction process governance risk factors are (a) pre-auction risk factors *(2.1)*, (b) during-auction risk factors *(2.2)*, (c) post-auction risk factors *(2.3)*, and (d) phase-independent risk factors *(2.4)*. The phase-independent risk factors represent auction process governance risk factors that cannot be exclusively mapped to a particular phase.

[17] It should be noted that the risk factors pertaining to the inadequacy in intangible resources (Dimension 1) and interfirm governance (Dimension 3) may also have similar temporal characteristics. They, however, lack the linear sequential characteristics that process governance entails. Hence, examining them based on the phase in which they occur is inappropriate. Instead, they are examined according to the sub-dimensions that exclusively characterize them.

Pre-auction risk factors: The pre-auction risk factors pertain to the design of RAs and the establishment of an effective communication channel with suppliers. Five risk factors were mapped to this sub-dimension. Both the buyer and the supplier panels rated inadequate supplier qualifications among the top risk factors *(2.1.1).* A common cause of concern is an incompetent supplier winning the auction. The buyer risks getting lured by a low cost but incompetent supplier, while competent suppliers risk losing the opportunity to win the business. It is, however, possible that qualified and competent suppliers may not have the capability to handle large volumes of business. It is particularly challenging for smaller suppliers when the lots are too large for their capability and interest, or when they are interested only in a portion of a larger lot. Improper lot structuring *(2.1.2)* can prevent smaller but competent suppliers from participating in RAs rendering the buyer unable to extract full benefits of RA use.

Once a buyer has chosen qualified suppliers to participate and designed the lots, it needs to make sure that it has provided sufficient information to suppliers regarding the RA process. Since the buyer's incentive for using RAs is to reduce price, suppliers often expect that the lowest bidder might be awarded the business. However, the buyer may have other criteria to determine the winner (Anderson et al. 2005a; Jap 2003; Jap 2007). When suppliers are not informed about the award terms prior to the RA *(2.1.3),* they can expect that low bidding suppliers may win the business. When low bidding suppliers are not awarded the business, it can result in supplier resentment against the use of RAs and reluctance to participate in RAs in future *(2.1.4).*

Our findings also suggest that not only what is being communicated, but also *how* it is communicated matters significantly. Reverse auction tools are not considered to be a rich medium of communication. They lack feedback immediacy, social cues, language variety, and personalization (Daft et al. 1986; Gattiker et al. 2007) as compared to other mediums of communication (e.g., face-to-face, telephone, and email). Using RA tools as the only medium of communication adversely impacts suppliers' ability to communicate with the buyer *(2.1.5).*

Suppliers cannot receive satisfactory response to their queries making it difficult to accurately estimate the cost structure. It can also lead to suppliers placing suboptimal bids.

During-auction risk factors: During-auction risk factors pertain to a supplier's bidding behavior, bidding behavior of its competitors, and the subsequent consequences. Three risk factors were mapped to this sub-dimension.

A supplier's likelihood of winning the business is largely determined by its bid in an RA. It is, thus, important for a supplier to be cautious when bidding. A small miscalculation or a typographical error can result in an erroneous bid. A supplier may not be allowed to back track on its final bid price after the RA. Hence, it may have no choice but to withdraw from the RA and not be considered for the buyer's business. The undesired bid, however, is not limited to misplaced bids. Suppliers can get caught in an auction fever where they bid on impulse to beat the competition *(2.2.1)* In the heat of the moment, a supplier can place an unrealistic bid that negates its profit margin.

Likewise, the bidding behavior of a supplier's competitors can also affect the likelihood of its winning the buyer's business. The bid price of a supplier is considered competitive only in relation to the other suppliers' bid prices. A supplier determines its bid price by estimating its cost structure based on the specifications provided by the buyer. It is, however, possible that other suppliers may underestimate their costs by not adhering to the specifications and may underbid *(2.2.2)*. This underbidding can create unrealistic cost differences between suppliers. These unrealistic cost differences can result in early attrition of quality suppliers due to aggressive bidding *(2.2.3)*.

Post-auction risk factors: One risk factor was mapped to this sub-dimension.
A supplier may not be able to sustain the bid price when either the bid placed in the RA event was too low or when the supplier's cost structure changes *(2.3.1)*. This may result in a supplier backing out of the RA or the contract with the buyer.

Phase independent risk factors: Phase independent risk factors either span multiple phases or cannot be mapped to one or more phases. Five risk factors were mapped to this dimension. These risk factors are discussed below.

In RAs, the focus is on price. However, a variety of relevant supplier capabilities including innovation, continuous improvements, development of new products, and keeping abreast with technological developments can get overlooked. Rather than working with suppliers to find alternate ways to reduce cost by involving them in planning and goal setting activities (Cusumano et al. 1991), a buyer can force them to cut down on their profit margin by putting them through market driven competition *(2.4.1)*. When the buyer users this approach, it signals that the suppliers' products and services are considered to be commodities *(2.4.2)*.

Use of RAs can be particularly ineffective when acquiring technologically sophisticated and complex products or services where suppliers can find it difficult to differentiate themselves. Reverse auction tools are generally not robust enough to process intangible and complex supplier information, and are not considered to be a rich medium of communication (Gattiker et al. 2007). Therefore, it can be difficult for a buyer to evaluate suppliers' full capabilities including non-price value adds and alternative products. By not being able to consider suppliers' non-price criteria, a buyer may take away suppliers' incentives to vie for its business *(2.4.3)*.

Although most of the activities related to RA planning and execution are under the buyer's sphere of influence, the corresponding risk factors concern suppliers as well. The most significant of such risk factors is the total cost of ownership (TCO). The total cost, in addition to the final bid price, can include such things as taxes, transportation, insurance, and switching costs. If not accounted for, the TCO can lead to disputes and can create friction between the buyer and suppliers *(2.4.4)*.

While costs other than the bid price concern buyers, suppliers have to not only determine their own cost structure but also estimate their competition's cost structure. Since the identity of other suppliers is usually unknown, a supplier is unaware whether other suppliers' bids reflect

lower profit margins or lower cost structures *(2.4.5)*. This lack of awareness makes it difficult for suppliers to determine the optimal price and bidding strategy.

4.5.4 Dimension 3: Interfirm Governance Risk Factors

Corresponding to the theories of interfirm governance, this dimension of risk factors entails agency and transaction cost issues that arise due to RAs and have a damaging impact on buyer-supplier relationships. The buyer is identified as the principal and the suppliers are identified as agents. Six sub-dimensions and 15 risk factors were mapped to this dimension. Two new sub-dimensions, i.e., reverse information asymmetry and principal opportunism, were devised to accommodate six risk factors that could not be mapped to any other sub-dimensions and were counterintuitive to the known constructs of interfirm governance. The risk factors are discussed according to the sub-dimensions.

Contractual hazards: Contractual hazard risk factors arise from the inability of a party to secure its interests through a contract. One risk factor was mapped to this sub-dimension. Unless the buyer provides suppliers with detailed specifications *(3.1.1)* for the products or services being auctioned, it can be difficult to rely on the contract to protect its interests when a supplier provides inferior products and services.

Small number bargaining: Small number bargaining risk factors arise from an imbalance between supply and demand in favor of suppliers. Three risk factors mapped to this sub-dimension are discussed below.

It is important for a buyer to study the market conditions by examining available suppliers, their product lines, their client bases, and the relationships among suppliers *(3.2.1)*. A buyer should ensure that it has enough qualified suppliers participating and actively bidding in the RA. Large suppliers can take advantage of their size, scale, and efficient cost structure to bid lower than smaller suppliers. Lower prices can make it difficult for smaller suppliers to withstand the market pressure that leads to their elimination from the market. Smaller suppliers getting eliminated from the market can result in adverse long-term impacts on the supply base *(3.2.2)*.

When the market is consolidated due to fewer suppliers, the buyer can find it difficult to generate sufficient bidding activity during an RA. Lack of competition and bidding activity in RAs precludes the buyer from obtaining lower prices *(3.2.3)*.

Reverse information asymmetry: We find evidence for reverse information asymmetry being a risk factor associated with RAs. Reverse information asymmetry arises when conditions resulting from the use of technology or the principal's behavior is such that the agent is unable to gather critical information needed to make important business decisions. One top ranked risk factor and four overall risk factors were mapped to this dimension.

The problem of hidden information is a well-explored agency problem, but the focus traditionally has been on the principal's perspective (i.e., information asymmetry for the principal). While some studies have called for examining the agent's perspective (Ahuja 2000; Gulati et al. 2007; Lawson et al. 2008), only a handful have tried to address the problem of information asymmetry for the agent (Dawson et al. 2011; Dawson et al. 2010). Since RAs induce competition among suppliers and the buyer determines to whom the business should be awarded, it has a stronger power position over suppliers. Reverse auctions condition suppliers to believe that by making them compete the buyer is looking for a supplier who offers the lowest price *(3.3.1)*. However, the buyer alone knows what factors it takes into account when awarding the business. Suppliers, on the other hand, are aware only of the price they bid in the RA. Suppliers' decisions, therefore, are influenced by the assumptions they make regarding the buyer's actions. This lack of critical information creates an illusion that a supplier needs to be the lowest bidder.

Opportunism (including goal incongruence and self-interest): Opportunism risk factors arise when suppliers act in their self-interest due to misalignment with the buyer's goals. Three RA risk factors were mapped to this sub-dimension. Both agency theory and transaction cost theory address supplier opportunism risk factors.

Reverse auctions negatively affect the supplier's goodwill towards the buyer since the buyer uses them to cut down on its procurement costs and suppliers are forced to compromise on

their profit margins. Suppliers can act opportunistically by first bidding low to gain the contract and then taking advantage of loopholes in the contract to increase prices *(3.4.1)*. While this affects the buyer, it also precludes other suppliers from earning the business. Moreover, to maintain profits, a supplier can introduce hidden costs not anticipated by the buyer that were not included in the contract. Not only does this hurt the buyer, but it also hurts the supplier's own credibility in the long run. The most common form of supplier opportunism, however, arises when the supplier compromises the quality of the product *(3.4.2)* or the quality of service and support *(3.4.3)* in order to cut the total cost and honor the offered RA bid price.

Principal opportunism (including goal incongruence and self-interest): Reverse auction risk factors pertaining to principal opportunism arise when the buyer (a) takes advantage of the information generated through RA tools that are not accessible to suppliers, and (b) uses its power position over suppliers to reduce procurement costs and extract relation specific rent. Five risk factors were mapped to this dimension.

Although there has been growing interest in the agent/supplier perspective pertaining to principal opportunism, only a handful of studies have tried to address this problem (Dawson et al. 2010; Hawkins et al. 2013; Joshi et al. 1997). If the agent can act in self-interest due to conflicting goals, then the principal too can be opportunistic when its goals are different from those of the agent. When a buyer uses RAs, it makes it obvious that it wishes to increase its profit margin by cutting down on procurement costs. Reduced procurement costs, however, are achieved by making suppliers compromise on their profit margins. By using RAs, therefore, the buyer acts in its self-interest at the expense of its suppliers.

While it can be argued that the principal opportunism risk factors identified by suppliers could be perception driven (Jap 2007), we suggest that those identified by buyers are not. The risk factors identified by the buyers are an acknowledgement of their own actions and behavior. Thus, we divide our discussion of these risk factors based on two attributes: (a) principal opportunism

risk factors identified exclusively by suppliers, and (b) principal opportunism risk factors identified by buyers or both buyers and suppliers.

Principal opportunism risk factors identified exclusively by suppliers: Two principal opportunism RA risk factors were identified exclusively by the supplier panel. A buyer can manipulate RAs by introducing artificially low bids, a phenomenon known as shilling *(3.5.1)*. Findings from prior studies suggest this risk factor to be more a perception than an actual risk factor (Jap 2002; Jap 2003; Jap 2007). Our findings suggest that the low richness of online RA tools as a communication medium (Daft et al. 1986; Gattiker et al. 2007) drives these perceptions. Suppliers can only see either their rank or the bid price. The limited information causes suppliers to become suspicious of the buyer's behavior, believing that the buyer is acting unethically or opportunistically. This lack of information and feedback, however, can also create suspicion among low bidders who later do not get invited for contract negotiations. When a non-incumbent supplier is not awarded the business, it may perceive that the buyer used the RA only to test the market and determine the current price. The supplier may suspect that the buyer has no intention of buying from other suppliers, but rather intends to use the RA outcome to exert pressure about pricing on its incumbent suppliers *(3.5.2)*. The incumbent suppliers, on the other hand, can perceive that the buyer is using the RA only to re-negotiate the current price. Since it is difficult for suppliers to verify the buyer's true intentions these perceptions can lead to loss of trust for the buyer.

Principal opportunism risk factors identified by buyers or both buyers and suppliers: Three principal opportunism RA risk factors were identified by the buyer panel, one of which was also identified by the supplier panel. These risk factors relate to the inappropriate use of RAs by the buyer. A buyer can opportunistically use RAs by intentionally including certain suppliers who will not be awarded the business *(3.5.3)*. These suppliers are included in the RA only to induce competition and drive prices down. A buyer can also be unfaithful to the RA process by accepting quotes outside of the RA and negotiating with suppliers that were not invited to bid *(3.5.4)*. A

buyer acts opportunistically and in self-interest when it denies sincere and competent suppliers the opportunity to win the business. When a buyer does not honor the award terms by awarding business to participating suppliers, it risks either their outright refusal to participate, or their unwillingness to provide their best bids in future RAs *(3.5.5)*.

Relational risk factors: The relational RA risk factors correspond to interaction-based non-contractibility between the buyer and suppliers (Mithas et al. 2008). Two risk factors were mapped to this sub-dimension. Interaction-based non-contractibility encompasses responsiveness, trust, and flexibility, which are three aspects critical to the longevity of interfirm relationships. The higher the degree of non-contractibility in an interfirm relationship, the less likelihood the buyer will use RAs (Mithas et al. 2008). Our findings suggest that using RAs prevents the growth of a long-term relationship *(3.6.1)*. Buyers that use RAs are perceived to (a) treat suppliers' products as commodities, (b) prioritize short-term monetary gains over long-term relationships with suppliers, and (c) weaken existing relationships by not considering their relationship with suppliers to be strategically important *(3.6.2)*.

4.5.5 Expert Interviews to Identify Controls

In order to gain insight into the controls that could be used to address the most highly ranked risk factors that surfaced in our Delphi study, we interviewed 14 experts, seven from each panel. The experts were asked to suggest their controls to address (a) the top five risk factors identified by their panel in the ranking phase of the Delphi study, and (b) other top ranked risk factors identified by their panel in the ranking phase that were common to both panels. Two lists, each with 11 risk factors, were developed to interview the experts from the buyer and supplier panels. Table 4.4 lists the risk factors and the corresponding panel of the interviewed expert. Risk factors for which experts from both panels were interviewed have been indicated as "Both". The average duration of each interview was 40 minutes (range 25-70 minutes). One expert from each panel was interviewed in person and the remaining interviews with 12 experts were conducted by phone or Skype. All the interviews were audio recorded and transcribed.

Table 4.4. Interview Round Risk Factors

Dimension	Sub-dimension	Risk factor	Panel of the interviewed experts
Inadequacy in Intangible Resources	Adoption of RA	Suppliers lack adequate knowledge of reverse auction process	Buyer
		Resistance by internal clients within buying organization to reverse auction procedures and outcomes	Buyer
		Lack of top management support	Buyer
Auction Process Governance		Inadequate supplier qualification	Buyer
		Award terms not clearly communicated prior to auctions	Buyer
		Singular focus on price does not factor in total cost of ownership	Both
		Omission of non-price criteria limits buyer's understanding of suppliers' full capabilities	Both
		Suppliers unable to maintain their offered auction price	Supplier
		The risk of other suppliers not adhering to the specifications and underbidding	Supplier
Interfirm Governance	Contractual hazards	Inadequately specified requirements	Both
	Small number bargaining	Lack of competition in the auction	Buyer
	Opportunism (including principal opportunism)	Buyer not faithful to the auction process	Buyer
		Quality of service and support could be reduced by suppliers to achieve offered price	Both
		Quality of the product could be reduced by suppliers to achieve the offered price	Supplier
	Relational risk factors (Interaction based non-contractibility)	No opportunity for relationship building	Supplier
		Weakens existing strategic relationships with suppliers	Supplier

Multiple control actions were suggested by the panelists to address each risk factor. Using an approach similar to the first phase of the Delphi study, we consolidated and refined the list of suggested control actions by grouping similar items together, removing duplicates and sharpening some descriptions to improve clarity. This process yielded a consolidated list of 33 unique control actions. A one-to-many relationship was observed between the risk factors and the control actions, i.e., one risk factor could be addressed by one or more control actions and one control action could address one or more risk factors. After examining the objective of each

control action, we determined that when grouped together the 33 control actions constituted 8 unique controls as shown in Table 4.5. Each control, thus, has a common objective that is achieved by one or more control actions.

We found seven controls to be input controls and one control to be an outcome control. No behavior controls were suggested to address the key risk factors. Input controls regulate the antecedent conditions of performance and are enforced prior to a contract (Cardinal 2001). Unlike behavior controls that manage task activities, and outcome controls that regulate products and service quality, input controls screen the suppliers for their capability, establish expectations for business practices, and provide incentives to achieve those expectations. Input controls are also implemented to educate internal stakeholders and suppliers about the RA process, and assess the market conditions prior to using RAs. Additionally, our findings suggest that (a) both buyers and suppliers are responsible for implementing input controls, and (b) input controls are both internal, i.e., a party monitors its internal activities, and external, i.e., one party monitors the other.

Table 4.5 shows the controls, the corresponding control actions, and the type of control (input or outcome control). The control actions are assigned codes to specifically identify each individual control action. These codes are used in our discussion and analysis of the risk factor dimensions and corresponding controls. Our discussion and analysis of the controls is organized according to the theoretical dimensions of the risk factors. Table 4.6 maps the relationship between controls and the RA risk factor dimensions and sub-dimensions. The discussion of controls and control actions is organized according to the corresponding RA risk factor dimensions.

Table 4.5. Controls and Control Actions

Type of Control	Control	Control Action	Code
Input	Buyer's Pre-Auction Evaluation of Suppliers	Buyer performs a stringent RFP process	C1
		Buyer performs a stringent RFI process	C2
		Buyer performs a background check on suppliers.	C3
		Buyer asks for pre-bid price	C4
		Buyer asks suppliers to show samples	C5
		Buyer evaluates suppliers by comparing capabilities	C6
		Buyer estimates low threshold bid price and ignores low bids	C7
Input	Buyer Designs Auction Rules and Incentives	Buyer establishes rules and ethical guidelines and adheres to them	C8
		Buyer establishes the benchmarks for the expected quality for service and support	C9
		Buyer establishes the benchmarks for the expected quality of the products	C10
		Buyer determines the award criteria upfront	C11
		Buyer awards the business pending qualification.	C12
		Buyer assures suppliers of a long term contract to give incentive	C13
		Buyer uses advanced e-sourcing tools and technology features to account for additional factors other than price	C14
Input	Buyer-Supplier Communication	Buyer communicates outside of the e-sourcing tool to explain specified requirements in detail	C15
		Buyer communicates with supplier(s) outside of the e-sourcing tool regarding their total cost structure	C16
		Buyer provides suppliers the opportunity to inform the buyer about their capabilities	C17
		Supplier communicates with the buyer face-to-face by requesting a personal meeting	C18
		Supplier asks clarification questions regarding the specified requirements	C19
		Buyer sends to the suppliers a sample(s) of the product(s) to enable them to comprehend the requirements better	C20
Input	Buyer Develops Readiness for RAs	Buyer allocates sufficient preparation time	C21
		Buyer have sufficient staff	C22
		Middle level management educates and convinces the internal stakeholders/top management	C23
		Buyer communicates with internal stakeholders to ensure adequacy and accuracy of requirements, and the expected total cost	C24
Input	Supplier Readiness	Supplier validates the requirements and attest to its capability	C25
		Supplier determines its lowest bid price and not bid below it	C26
		Supplier maintains its integrity and does not cheat the buyer on quality	C27

Type of Control	Control	Control Action	Code
Input	Buyer's Pre-Auction Assessment of Supplier Competition	Buyer uses reverse auctions selectively which there is a sufficiently large supply base	C28
		Buyer conducts RAs only when it has sufficient number of participating suppliers	C29
Input	Buyer Facilitates Supplier Readiness for RAs	Buyer trains suppliers on the reverse auction tool and the process	C30
		Buyer provides sufficient time for suppliers to prepare bid	C31
Outcome	Buyer Evaluates Post Auction Performance	Buyer constantly monitors and provides feedback to suppliers on the quality of service and support	C32
		Buyer holds its procurement managers accountable for their performance	C33

4.5.6 Controlling Inadequacy in Intangible Resources RA Risk Factors

The experts were interviewed regarding three RA risk factors associated with inadequacy in intangible resources. Three controls were identified for these risk factors. The primary controls pertain to the readiness of the buyer and suppliers, and are complemented by effective buyer-supplier communication. The buyer needs to cross two hurdles when it comes to addressing risk factors characterized by the adoption of RAs. First, it needs to create internal conditions conducive for the RA process to succeed. Without sufficient internal support, the buyer may not be able to award business based on the outcome of the RA. Second, it needs to make sure suppliers understand the RA process and are able to place proper bids during the RA event.

Addressing both issues requires education and training. First, the buyer needs to educate internal stakeholders and top management about the RA process and obtain their approval prior to using RAs *(C23)*. The buyer should also make sure that participating suppliers are aware of how the RA process works, because suppliers unfamiliar with the process and the technology are not likely to successfully place their best bids *(C30)*. The buyer should therefore train them by running mock RA events and answering their queries regarding rules and award criteria *(C16)*.

Table 4.6. Mapping Controls and Risk Factors

Risk Factor Dimension	Inadequacy in Intangible Resources	Auction Process Governance	Interfirm Governance			
Sub-dimension	Adoption of RA	All Phases	Contractual Hazards	Small Number Bargaining	Opportunism (including principal opportunism)	Relational Risk Factors (interaction based non-contractibility)
Key Control	Buyer develops readiness for reverse auctions	Buyer's pre-auction evaluation of suppliers	Buyer-supplier communication	Buyer's pre-auction assessment of supplier competition	Buyer's pre-auction evaluation of suppliers	Buyer-supplier communication
Supportive Control	Buyer facilitates supplier readiness for reverse auctions	Buyer designs auction rules and incentives	Buyer's pre-auction evaluation of suppliers	Buyer's pre-auction evaluation of suppliers	Buyer designs auction rules and incentives	Buyer's pre-auction evaluation of suppliers
Additional Complementary Controls	Buyer-supplier communication	Buyer-supplier communication	Buyer develops readiness for reverse auctions		Supplier readiness	Buyer designs auction rules and incentives
		Buyer develops readiness for reverse auctions	Buyer facilitates supplier readiness for reverse auctions		Buyer evaluates post auction performance	Buyer's pre-auction assessment of supplier competition
		Supplier readiness				

4.5.7 Controlling RA Process Governance Risk Factors

The experts were interviewed regarding six RA risk factors that mapped to this dimension. Five controls were identified to address these risk factors. The risk factors characterized by the process governance of RAs have several consequences. For a buyer, these risk factors result in it not being able to extract the desired benefits of RAs. To address these risk factors, the buyer should first evaluate suppliers by performing stringent request for proposal (RFP) and request for information (RFI) processes, and examining their prior records *(C1, C2, and C3)*. After qualifying eligible suppliers, the buyer should make sure that it understands their capabilities beyond the qualification criteria *(C5, C6)* so it knows whether or not they have any value adds (i.e., non-price factors other than the offered price). To do so, the buyer should give suppliers the opportunity to communicate their capabilities *(C17)* and hold face-to-face meetings *(C18)* where suppliers get the opportunity to attest to their capabilities and validate the buyer's requirements *(C25)*. The buyer, however, should keep in mind that any added value that these qualified suppliers offer often come with a price, and that the offered bid price may not be the total price of the product or service being auctioned. The buyer, therefore, should take the total cost into account *(C16)*. One suggested method for taking the total cost of ownership into account is the use of advanced e-sourcing tools and technology features that can factor in the majority of these costs *(C14)*. Since managing all these tasks can be time consuming, it is important that the buyer allocate sufficient staff for such projects *(C22)* and provide them with enough time to prepare for the RAs *(C21)*. When ready to conduct the RA, the buyer should determine the award criteria upfront *(C11)*, communicate it to all the participating suppliers, adhere to the award criteria when awarding the business *(C12)*, and hold its own procurement personnel accountable for the suppliers selected to participate in RAs *(C8, C33)*. These are important steps to ensure fairness since suppliers invest valuable time and resources to participate in RAs. If not done, suppliers may lose confidence in the buyer's integrity and the RA process. As one expert from the supplier panel said *"I have seen cases where award terms were communicated but were not*

followed. It hurts buyer's credibility in the market. I would much rather prefer a situation where suppliers did not win the award but believed the reverse auctions were conducted fairly."

Like buyers, suppliers too are not always able to extract the desired benefits of RAs due to the risk factors associated with auction process governance. It is, however, also contingent on the buyer to address the supplier risk factors because, if these risk factors materialize, they may have repercussions for the buyer as well. Suppliers tend to bid low when they do not adhere to the specifications and underestimate their cost structure. This not only denies other capable suppliers the opportunity to win the business, it also denies the buyer the true market price. The buyer should therefore carefully examine the prices provided by suppliers in their proposals, during the RFP process *(C1);* and establish benchmarks for expected quality to ensure that the offered low price is genuine *(C9, C10)*. If not done, low bidders may win the business, but will not be able to sustain the offered price for very long. The buyer can address this issue by estimating a low threshold for the offered price and ignoring any bids that go below that limit *(C7)*. Suppliers too should do their part by establishing their own threshold and not bid any lower than that limit *(C26)*.

4.5.8 Controlling Interfirm Governance RA Risk Factors

Controlling contractual hazard risk factor: Experts were interviewed regarding one RA risk factor that mapped to this sub-dimension. Four controls were identified to address the risk factor. In the interviews, experts from both the panels indicated that inadequate specification of requirements is one of the most common reasons for the failure of RAs during bidding and negotiations. Two critical steps were identified to address this risk factor. First, the buyer should ensure the adequacy and accuracy of the requirements by consulting internal stakeholders *(C24)*. Second, the buyer should establish a strong communication channel with suppliers to allow them the opportunity to clarify specifications *(C15, C19, and C20)*. Sometimes, however, even if the specifications are sufficient, some suppliers may not be able to interpret them accurately due to incompetence or a lack of sufficient preparation time. The buyer should evaluate and compare

suppliers prior to the RA, select competent suppliers, and provide selected suppliers with sufficient time to prepare for the RA *(C31)*.

Controlling small number bargaining risk factor: The experts were interviewed regarding one RAs risk factor that mapped to this sub-dimension. Two controls were identified to address the risk factor. Risk factors associated with small number bargaining shift the power equation in favor of suppliers. Thus, it is important for the buyer to address them prior to the RA. The buyer should assess the competition by making sure that there is a large enough supply base that can be invited to participate in an RA *(C28)*. The buyer should then invite a sufficient number of capable suppliers to compete *(C29)*. Consistent with prior studies (e.g., Jap 2007) that suggest five or more suppliers, experts from our panel suggested that at least six suppliers should be included, and that caution should be exercised if there are three or fewer suppliers participating in the RA. A buyer should also request pre-bid prices to ensure that the participating suppliers are likely to quote a reasonable price during the RA *(C4)*.

While buyers were interviewed about the risk factor of lack of competition, suppliers were interviewed about the risk factor of *adverse long-term impact on the supply base*. No controls were suggested to address this risk factor. Experts suggested that this risk factor could not be controlled. Therefore, this risk factor has not been listed in Table 4.4.

Controlling opportunism risk factors: The experts were interviewed regarding three RA risk factors (one of which was principal opportunism) that mapped to this sub-dimension. Four controls were identified to address these risk factors. While prior studies suggest several post-contract controls to address agent opportunism, our findings suggest the need for both pre and post-contract controls. We suggest that strong pre-contract input controls lead to less taxing post-contract controls. To enforce input controls the buyer should evaluate and compare suppliers on their capability *(C1, C2, C3, and C6)* and enforce strict auction rules by establishing benchmarks for expected quality of products, and service and support *(C9, C10)*. Suppliers too should determine a bidding strategy and not bid below their threshold price so that later if awarded

business, they are not forced to cut corners on quality to honor the price *(C26, C27)*. After awarding business the buyer can constantly monitor suppliers and hold them accountable by providing feedback based on the quality benchmarks determined prior to the RAs *(C32)*.

Though several controls are suggested to address agent opportunism, no tenable measures were proposed to address principal opportunism. This is because when using RAs the power to make informed decisions lies with the buyer and it is not possible for suppliers to gather or purchase information from the buyer. Moreover, the buyer is not legally bound to award business to suppliers based on the outcome of the RA. Suppliers have little to no control over how RAs are conducted by a buyer and how the buyer makes award decisions. As one expert from the buyer panel put it *"It is fairly common where buyers feel empowered to deviate from the process that they may or may not have communicated with suppliers. You get into borderline of ethics and integrity issues here."* In fact several experts from the buyer panel admitted to having been either directly involved or having first-hand knowledge of being unfaithful to the process. One expert when explaining such an incident said *"We were not faithful to the auction process; we were not faithful to the suppliers."* Another expert said, *"The integrity of the auctions depends on the group responsible for conducting the auctions. Yes I have seen and been a part of such auctions. It was something I was asked to be involved in where there were separate negotiations going on while the auction was taking place. It was happening backstage. It was clear what was going on was less than ethical. There were phone calls going on during the auction where separate negotiations were taking place."* The only control factor suggested to address buyer opportunism, therefore, was for the buyer to establish and adhere to the rules and ethical guidelines *(C8)*.

Relational risk factors: Experts were interviewed regarding two RA risk factors that mapped to this sub-dimension. Four controls were identified to address these risk factors. Relational risk factors were ranked highly by suppliers. By putting suppliers through RAs and making them compete over price, the buyer communicates that it prefers lower costs over strong business relationships. Findings from the interviews suggest that the more experienced with RAs

the suppliers are, the more they are aware of the nature of the business and the market. Experts from the supplier panel seemed to suggest that RAs are today's reality and suppliers should be willing to accept the competitive nature of the business. An expert from the supplier panel said: *"To be very honest, we (suppliers) need to know that we are not alone in this world. There is tough competition out there. Though you always strive for good relationship with buyers but it is the nature of the business where you can lose your client."* It is not losing out to the competition that they consider problematic but how the buyer kept them in the loop through the RA process that affects their perception about the buyer. Suppliers seem to have a positive impression of buyers who are willing to communicate outside of the online RA tools by either talking over the phone or meeting with them in person *(C15, C16, and C18)*. As long as suppliers are given the incentive of a long-term contract if awarded the business *(C13)* and are aware that the buyer evaluated all suppliers on their merit alone, they do not consider the buyer to have acted opportunistically *(C1, C17, and C28)*. Incumbent suppliers who are able to maintain their business after cutting down on their profit margin, however, consider RAs to be damaging to the relationship unless the buyer provides them detailed feedback on their performance in the RA process. One expert from the suppliers' panel said: "*The use of reverse auctions and forced price reduction takes away the suppliers' incentive to be flexible for their customer. Why would a supplier be willing to accommodate the buyer's requirements when it is selling its products at a very lean profit margin?*" and another panel member suggested: "*Reverse auctions should be used selectively. The buyer suggests that it is not in need for relationship with any of its suppliers when it uses reverse auctions for all of its categories.*"

4.6 Implications of the Study

We developed a comprehensive list of RA risk factors from both the buyer and supplier perspectives. We examined the similarities and differences in their perspectives of RA risk factors, and developed a list of controls that can be used to address the key risk factors. We now discuss the implications of our findings for research and practice.

Theoretical elaboration of the concept of risk factors in RA: Based on the differences and similarities between the buyer and supplier ranking of the risk factors we identified three key findings. First, buyers emphasize risk factors pertaining to transaction costs, and inadequacy in intangible resources for RAs. Second, suppliers emphasize opportunism and relational risk factors that arise due to RAs. Third, the majority of the risk factors are associated with governing the RA process. Buyers are most concerned with the pre-auction risk factors, while suppliers are focused on during-auction risk factors, and both buyers and suppliers are concerned about phase-independent risk factors. These findings suggest that theoretically it is meaningful to differentiate RA risk factors based on buyers' and suppliers' perspectives and the orientation of the risk factors towards inadequacy in intangible resources, auction process governance, and interfirm governance,

Extensions of the theory of relationship constraints: While IT is traditionally seen as a facilitator of information sharing and diffusion, we find that IT can also be used to induce information asymmetry by giving buyers an advantage in a transactional exchange. A buyer can use its advantageous position over suppliers to extract benefits and generate extra rent. Through these findings, we extend the theory of relationship constraints (Dawson et al. 2010) in two respects. First, the theory of relationship constraints suggests that a party with an information advantage signals some meaningful information about itself to a disadvantaged party. The information-disadvantaged party screens the advantaged party by assessing its suitability to be a business partner. Since both parties may have some advantageous information, they can simultaneously signal and screen one another. Our findings suggest that use of RAs leads to circumstances in which the information-advantaged party can also screen the disadvantaged party. When a buyer already has an established relationship with an incumbent supplier, it can use RAs to assess market price, accurately estimate the incumbent's and other suppliers' cost structures, and use this information advantage to reduce its procurement costs. Thus, we find that

RA use can induce information asymmetry in favor of the buyer, which is a situation that we refer to as reverse information asymmetry.

We also contribute to the theory of relationship constraints by finding evidence of principal opportunism. We find that reverse information asymmetry begets principal opportunism as previously suggested by Dawson et al. (2011; 2010). The principal opportunism risk factors that we identified from the buyer panel represent a principal's perspective. In fact, the buyers who served on the panel admitted during individual interviews to have opportunistically used RAs. Thus, our findings support the idea of principal opportunism and contribute to the prior research (Hawkins et al. 2013; Joshi et al. 1997; Miller et al. 2011) by showing how principal opportunism can arise due to the use of technology for a business activity.

Role of input controls: Our findings reveal the importance of establishing and enforcing stringent input controls to cut the costs of post-contract controls. Specifically, controls pertaining to readiness and preparation for RAs and buyer-supplier communication are particularly important. First, pre-auction evaluation of suppliers and design of auction rules and incentives are effective to address risk factors associated with RA process governance and opportunism, and these controls can be complemented by controls related to buyer-supplier communication, and controls related to buyer and supplier readiness to use RAs. Second, buyer-supplier communication and ensuring buyer and supplier readiness to use RAs are effective to safeguard against contractual hazards, small number bargaining, relational and adoption risks. Third, pre-auction assessments of competition along with post-auction evaluation of performance are also effective in addressing small number bargaining risk factors. Overall, these findings underscore the need for tighter input controls to mitigate post-contract risk factors.

Practical implication: Buyers and suppliers can utilize RAs more effectively by being aware of the other party's perspectives on RA risk factors and establishing controls to mitigate the risks. They can use the elaborate list of risk factors and control actions to guide their RA facilitated procurement projects and can revise their strategy for future participation in RAs.

4.7 Limitations and Directions for Future Research

Although our study generated important insights on risks and controls in RAs by utilizing multiple Delphi panels and elaborate interviews with experts, it has its limitations that can be a basis for related future research. First, we identify and characterize the risk factors and controls. Future research can follow up on our study with a survey to assess the extent to which the risk factors affect the success of RAs. Second, future research can examine the extent to which controls identified in our study can mitigate the risk factors in different buyer contexts (e.g., type of good/service being procured). Third, we identify controls only for a select number of risk factors (i.e., the key risks). Future research can expand the search to other risk factors and identify additional controls. Lastly, methodologies similar to the Delphi methodology have been suggested for knowledge generation exercises (e.g., repertory grid methodology). Future research can replicate a study like this and examine whether using alternate methodologies can report any significant differences in the findings.

4.8 Conclusion

Our findings reveal that the classic theoretical perspectives on interfirm governance do not adequately explain the risk factors in an IT-enabled B2B exchange context, specifically RAs, and that two classes of risk factors— inadequacy in intangible resources and auction process governance – are important. We find that there are salient differences in buyer and supplier perspectives on risks across all three classes of risk factors. We extend the theory of relationship constraints as we find the risk factors to include reverse information asymmetry and principal opportunism, both of which are detrimental to the agent. Finally, we find that stringent input controls can address most of the key risk factors.

4.9 Appendix 4.A — Complete List of Reverse Auction Risk Factors and Risks

Table 4.7. Reverse Auction Risk Factors and Risks

Risk Factor Sub-dimension	Panel	Risk Factor	Risk
Adoption of RAs	Common	Lack of top management support	Buyer unable to enforce outcomes of the RA
	Common	Suppliers lack adequate knowledge of reverse auction process	Buyer unable to extract RAs' desired benefits
	Buyer	Lack of technology resources and skills limits participation by suppliers	
	Buyer	Resistance by internal clients within buying organization to reverse auction procedures and outcomes	Buyer unable to enforce outcomes of the RA
	Supplier	Custom challenges	
Auction Process Governance (Pre-Auction)	Common	Inadequate supplier qualification	Buyer unable to extract RAs' desired benefits
	Common	Award terms not clearly communicated prior to auctions	
	Buyer	Improper lot structuring	
	Buyer	Reluctance of suppliers to participate	
	Buyer	Risk of price increase if pre-bids are not used	
	Supplier	Communication barriers create ambiguity regarding buyers' requirements	Supplier unable to place an optimal bid
	Supplier	Suppliers are forced to disclose sensitive information (e.g., pricing structure, manufacturing processes)	Supplier's critical competitive information compromised
	Common	Unreliable technology	
Auction Process Governance (During Auction)	Common	Increasing levels of price visibility can discourage supplier participation	
	Buyer	Too high or too low starting bids	Buyer unable to extract RAs' desired benefits
	Supplier	Early attrition of quality suppliers due to aggressive bidding	
	Supplier	Impulsive bidding leads to unrealistically low bids	Increased financial vulnerability of suppliers
	Supplier	The risk of other suppliers not adhering to the specifications and underbidding	Supplier's unsuccessful participation due to unfair actions/rules by the buyer or other suppliers
	Supplier	Security of suppliers' bid compromised	Supplier's critical competitive information compromised
	Supplier	Inability to correct bids that are mistakenly placed	Increased financial vulnerability of suppliers

Risk Factor Sub-dimension	Panel	Risk Factor	Risk
Auction Process Governance (During Auction)	Supplier	Technology features (e.g., auto bid) reduce supplier control over bidding process	Supplier unable to place an optimal bid
	Supplier	Lack of transparency of loading (or weighting) factors placed by buyer on a supplier's bids hampers bidding strategy	
	Supplier	Suppliers unable to bid strategically when last submitted bid price is not revealed	
	Supplier	Lack of flexibility in payment terms disadvantage some suppliers during bidding process	
Auction Process Governance (Post-Auction)	Common	Suppliers unable to maintain their offered auction price	Increased financial vulnerability of suppliers
	Supplier	Lack of post-auction feedback erodes supplier's confidence in the reverse auction process.	Loss of credibility/reputation among business partners
Auction Process Governance (Phase Independent)	Common	Omission of non-price criteria limits buyer's understanding of suppliers' full capabilities.	Buyer unable to extract RAs' desired benefits
	Common	Singular focus on price does not factor in total cost of ownership	
	Common	Inappropriate time allocation for auction	
	Buyer	Legal risk	Buyer unable to enforce outcomes of the RA
	Buyer	Dependency on third- party auction service provider	Buyer unable to extract RAs' desired benefits
	Supplier	Reduced profit margin	Increased financial vulnerability of suppliers
	Supplier	Commoditizing innovative products/services	
	Supplier	Lack of awareness of who you are competing with and their cost structures	Supplier unable to place an optimal bid
	Supplier	Suppliers cannot recoup their design and engineering costs	Increased financial vulnerability of suppliers
	Supplier	Overhead costs required for ongoing participation puts stress on already tight budgets	
Information Asymmetry	Common	Suppliers withholding their best price for post auction negotiation	Buyer unable to extract RAs' desired benefits

Risk Factor Sub-dimension	Panel	Risk Factor	Risk
Reverse Information Asymmetry	Supplier	Unclear standards of compliance because of lack of maturity of reverse auction process	Supplier's unsuccessful participation due to unfair actions/rules by the buyer or other suppliers
	Supplier	Lose an auction to a supplier who subcontracts to a lower quality foreign supplier	
	Supplier	Illusion that supplier needs to offer the lowest price to be awarded the business	
	Supplier	Award volume not guaranteed making it difficult to price	Supplier unable to place an optimal bid
Agent Opportunism	Common	Quality of service and support could be reduced by suppliers to achieve offered price	Supplier's breach of contract/loss of goodwill for the buyer
	Common	Quality of the product could be reduced by suppliers to achieve offered price	
	Supplier	A competing supplier may bid low to gain the contract and then raises prices once the buyer is locked in	Supplier's unsuccessful participation due to unfair actions/rules by the buyer or other suppliers
	Supplier	Suppliers lose credibility by having to introduce hidden costs in order to maintain profitability	Loss of credibility/reputation among business partners
Principal Opportunism	Common	Buyer not faithful to the auction process	Supplier's unsuccessful participation due to unfair actions/rules by the buyer or other suppliers
	Buyer	Failure to honor award terms deters future supplier participation	
	Buyer	Inclusion of suppliers who will not be awarded the business	
	Supplier	The risk of buyer manipulating the auction by introducing artificially low bids	
	Supplier	Buyers create distrust when they use reverse auctions to test the market with no intention of buying	
Contractual Hazards	Common	Inadequately specified requirements	Buyer unable to extract RAs' desired benefits
	Supplier	Intellectual IP risks	Supplier's critical competitive information compromised

Risk Factor Sub-dimension	Panel	Risk Factor	Risk
Small Number Bargaining	Common	Adverse long-term impact on supply base	Increased financial vulnerability of suppliers
	Common	Supplier collusion	Buyer unable to extract RAs' desired benefits
	Buyer	Lack of competition in the auction	
	Buyer	Market conditions not conducive for reverse auctions	
	Buyer	A supplier has more power than the buyer	Buyer unable to enforce outcomes of the RA
	Buyer	Empowering uncompetitive incumbents	Buyer unable to extract RAs' desired benefits
Relational	Buyer	Risk of losing investments with the incumbent supplier	Loss of relationship specific investments
	Supplier	Being stuck with inventory when incumbent supplier loses auction	
	Buyer	Damage to buyer's reputation	Loss of credibility/reputation among business partners
	Supplier	Reverse auctions give incumbents unfair advantage	Supplier unable to place an optimal bid
	Supplier	Buyers practice favoritism with preferred suppliers	Supplier's unsuccessful participation due to unfair actions/rules by the buyer or other suppliers
	Common	Weakens existing strategic relationships with suppliers	Weak buyer-supplier relationship
	Supplier	No opportunity for relationship building	

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