BUSINESS AND AUDIT RISKS ASSOCIATED WITH ERP SYSTEMS: KNOWLEDGE DIFFERENCES BETWEEN INFORMATION SYSTEMS AUDIT SPECIALISTS AND FINANCIAL AUDITORS

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Abstract

The purpose of this study is to examine the extent to which financial auditors recognize differences in the nature and extent of unique business and audit risks associated with enterprise resource planning (ERP) systems, as compared to traditional computerized (non-ERP) systems. We also investigate financial auditors' level of confidence in assessing such risks and their propensity to seek consultation with information systems (IS) audit specialists in their firm. The research hypotheses are framed in accordance with the knowledge acquisition model articulated by Libby (1995) and Libby and Luft (1993).

A total of 83 financial auditors and 82 IS audit specialists participated in an experiment in which 'system type' was manipulated as either ERP or non-ERP. All participants were CPAs. The realistic case contained a seeded control weakness. Including a measured variable (auditor type) and manipulated variable (system type) in a between-subjects design of this nature is a recommended approach when investigating the effect of knowledge differences between specialists and non-specialists (Frederick and Libby 1986, Libby 1985).

The findings indicate that financial auditors were significantly less concerned than IS audit specialists with the following heightened risks of the ERP environment in the experimental case: business interruption, network security, database security, application security, process interdependency, and overall control risk. Additionally, financial auditors did not recognize the heightened risks of a seeded control weakness. Financial auditors were also highly confident in their ability to assess risks in both an ERP and non-ERP environment; however, IS audit specialists were less confident in financial auditors' abilities to recognize unique risks posed by ERP systems. Finally, financial auditors were unlikely to engage the services of the IS risk management practice within their firm to assist in assessing computer system risks in an ERP system environment, suggesting that potential financial statement and audit risks may go unidentified.

Data is available from the authors; however, requests for data should specify the intended use.

Key Words: enterprise resource planning, ERP, audit risks, business risks, audit specialists

Enterprise resource planning (ERP) systems encompass numerous business applications, such as general ledger, payroll, supply chain management, manufacturing and business intelligence. Although very costly to implement, ERP systems have been adopted by many companies in recent years due to the potential for lower operating costs, shorter cycle times, and higher customer satisfaction (Brown 1997). Successful adoptions of ERP systems have also been linked to enterprise-wide re-engineering efforts and implementation of best practices (Scheer and Habermann 2000; Soh et al. 2000).

Despite their acclaimed advantages, ERP systems pose potentially heightened business and audit risks in some areas due to the presence of tightly-linked automated interdependencies among business processes and reliance on relational databases. In particular, ERP systems create substantial concerns about business interruption, system security, database security, and process interdependency risks (Girard and Farmer 1999). As will be discussed, several of these risks may result in greater control risks (e.g., lack of segregation of duties) and/or have a direct, material financial statement impact (e.g., invalid transactions, misclassifications, duplicate payments to vendors, and potential going concern issues relating to business interruptions) or require additional disclosures.

A recent statement by the Public Oversight Board (POB) highlights its concerns regarding the ability of auditors to properly assess risks arising from rapidly evolving information processing systems (POB 2000). Specifically, the POB states (p. 171):

> Increasingly, auditors will find it necessary to understand fully the risks associated with new and advanced business information systems, and the controls that are needed to respond to those risks. Auditors also will find that they must expand their technological knowledge and skills, devise more effective audit approaches by taking advantage of technology, and design different types of audit tests to respond to new business processes. Highly skilled technology specialists will become even more essential members of audit engagement teams.

Since ERP systems represent the computing environment of choice among many major corporations across the world, one would expect a great deal of interest and activity in this area from audit researchers. However, to our knowledge, no prior auditing studies have investigated risk differences in ERP and non-ERP computing environments.

The purpose of the current study is to provide a preliminary *ex ante* investigation of unique ERP system risks by examining differences between financial auditors and Information Systems (IS) audit specialists with respect to their assessments of business and audit risks associated with ERP systems, as compared to non-ERP ("legacy") systems. We also investigate the level of auditor confidence in assessing risks and the extent to which financial auditors seek consultation with IS audit specialists in the firm. Importantly, the effectiveness of the audit engagement may be significantly impaired if financial auditors fail to properly consider the level and nature of risks associated with different computer environments.

As recommended when investigating the 'expertise paradigm' (Frederick and Libby 1986, Libby 1985), a between-subjects experiment was designed wherein expertise was measured (IS audit specialists and financial auditors) and the variable of interest was manipulated (ERP and non-ERP system). Eighty-three financial auditors and 82 IS audit specialists, all CPAs, participated in this study. Participants were provided with a realistic case that contained a seeded control weakness (i.e., a network manager controls passwords and user privileges without routine independent authorization or review). The type of computer system (ERP and non-ERP) was manipulated in the case materials. After reading the case, IS audit specialists and financial auditors were asked to assess specific business and audit risks. The seeded control weakness and the risk areas examined were identified through a review of the literature and meetings with focus group participants, who were experienced IS audit specialists.

The findings indicate that financial auditors are significantly less aware and concerned than IS audit specialists about the following heightened risks in the ERP environment of the experimental case: business interruption, network security, database security, application security, process interdependency, and overall control risk. As anticipated, financial auditors did not provide significantly higher assessments for risks linked with the seeded control weakness in the case, while the IS audit specialists did. Additionally, financial auditors were very confident in their ability to assess risks in an ERP environment, whereas IS audit specialists were considerably less confident in the ability of financial auditors to assess such risks. Finally, financial auditors were unlikely to engage the services of the IS audit specialists to assist in risk assessment in an ERP system environment. In all, the findings suggest that potential business and audit risks may go unidentified by financial auditors in ERP system computing environments.

The next section reviews relevant literature and identifies the research hypotheses. Subsequent sections describe the research method and present the findings. The final section discusses the results and offers implications for future research and audit practice.

RELEVANT LITERATURE AND HYPOTHESES

ERP SYSTEMS

Enterprise resource planning (ERP) systems are defined as "information systems packages that integrate information and information-based processes within and across functional areas in an organization" (Kumar and Hillegersberg 2000). Vendors offering such systems include SAP, Oracle, PeopleSoft, and JD Edwards. ERP systems differ from non-ERP computer systems in that business processes are integrally linked through workflow automation and relational databases, which can facilitate real-time capturing and processing of economic

events. As such, ERP systems offer a number of significant potential operational and control advantages over traditional (non-ERP) systems. For instance, once a transaction is captured all subsequent processes are automatically updated, thereby, for example, greatly reducing the likelihood of failure to record and bill a shipment (completeness). Despite advantages of this nature, there have been a number of widely publicized problems with ERP systems, including business interruptions due to tightly-linked automated interdependencies among business processes, weaknesses in internal controls, and excessive implementation costs and delays (Wah 2000; Niccolai and LaMonica 1999).

The interdependent nature of ERP system applications exposes a company to significantly different business and audit risks than traditional (legacy) computer systems. In particular, ERP systems pose substantial concerns about business interruption, system security, and process interdependency risks. Importantly, ERP systems represent more than enhanced information processing technology, they also automate interdependencies among business processes, increase information security concerns, and often entail significant re-engineering efforts. Accordingly, the expanded scope of ERP systems can lead to heightened business risks and the potential for financial statement misstatements, misclassifications, and defalcations (Gibbs and Keating 1995; Helms 1999; Lilly 1997; Manello and Rocholl 1997; Pfenning 1999; Turner, 1999 and Wah 2000). For instance, Gibbs and Keating (1995) discuss the impact of reengineering on controls. They argue:

> Control environments have been shaken and shifted as a result of downsizing, flattening, and decentralization trends in business. Many of the controls on which auditors have traditionally relied, such as separation of duties and authorizations, actually tend to work at cross-purposes to the goals of the reengineered, virtual corporation…Controls in this new environment increasingly will move more toward automated controls and away from those that require manual intervention (p. 46).

With the potential for lower segregation of duties there is a correspondent increase in control risk in some ERP systems and enhanced likelihood for misstatements of all types, e.g., the occurrence of fictitious or erroneous transactions. In recent interview study by Wright and Wright (2001), IS audit specialists indicate other examples of unique, heightened audit risks in an ERP setting, such as problems of duplicate vendor payments due to the appearance of vendor names in multiple forms in the master database, control weaknesses occurring as a result of the use of "bolt-on" systems (i.e., applications from another vendor(s) to supplement the ERP system), data integrity, under-billing, unrecorded payments, and greater risks of fraud as the focus shifts from segregation of duties to greater access.

GUIDANCE ON ASSESSING COMPUTER SYSTEM RISKS

The Committee of Sponsoring Organizations (COSO) report (1992) provides a framework for the consideration of control risks, which expands the focus of the traditional view of controls at the detailed account and assertion level to include a global business perspective. The COSO framework was integrated into SAS 55 (1988) and 78 (1995). These standards direct the auditor to consider broader business and control risks of a company, which can have a direct impact on potential misstatements in the financial statements or on appropriate disclosures.

More explicit consideration of a client's business risks is encapsulated in the recent strategic systems audit approaches adopted by some auditing firms. For instance, KPMG's Business Measurement Process (BMP) approach directs auditors to identify a client's business risks, strategies, and processes. Then, auditors are directed to document critical success factors within each process and key performance indicators used by management to evaluate whether objectives are being attained (Bell et al. 1997).

Consistent with strategic systems audit approaches, the Information Systems Audit and Control Foundation (1998) formulated the 'Control Objectives for Information and Related Technology' (COBIT) framework. COBIT follows a business orientation that begins with business objectives, which drives information systems strategy (e.g., planning and organization of information technology) and the subsequent evaluation of risks and controls over information processing.

Taken as a whole, COSO, holistic audit approaches, and COBIT highlight the necessity for financial auditors to continually assess evolving business and audit risks arising from the infusion of new information technology into business organizations. Auditors' recognition of the unique risks posed by ERP systems is vital to the accomplishment of a global risk evaluation approach.

The public oversight board (POB) recently discussed the issue of unique risks and controls posed by increasingly sophisticated information processing systems (POB 2000). The board encouraged auditors to expand their knowledge of new business-oriented information systems, as such knowledge would facilitate the development of more effective audit approaches. The POB also recognized the need to attract and retain qualified technology specialists for audit support. However, the POB further stated: "auditors cannot cede addressing all technology matters to technology specialists" (p. 171), suggesting that financial auditors must be aware of the unique risks posed by new technology, such as ERP systems.

PRIOR RESEARCH

To date, no empirical research has compared the incidence and nature of errors or fraud of an ERP system to a legacy (non-ERP) computing system. However, in a study of detected errors, Bell et al. (1998) reported significant variations in the frequency and causes of errors for a

traditional computerized accounting system versus a manual system. They concluded by emphasizing the need to "adequately consider the nature and reliability of such systems in the planning stages of an engagement" (p. 13). It is reasonable to posit that this conclusion extends to the importance of evaluating the controls and risks of an ERP system, which typically has a considerably enhanced scope and business impact than a non-integrated computerized accounting system.

Theory and research findings presented by Solomon et al. (1999) provide a basis for expecting that IS audit specialists possess a knowledge differential over financial auditors, which is likely to result in more comprehensive and accurate risk assessments of computing environments, especially the more complex ERP setting. Using Libby's (1995) model of knowledge acquisition (experience leads to knowledge), Solomon et al. (1999) suggested that industry-specialist auditors possess a knowledge differential over non-specialists due to the specialists' more focused indirect experience (e.g., education and training) and direct on-the-job experience. Thus, while differences in the declarative knowledge (e.g., memory stores of specific facts and events) and procedural knowledge (various schemata for processing information) of specialists and non-specialists are difficult to observe directly, such a knowledge differential can be inferred via their judgments (e.g., risk assessments) (Frederick and Libby 1986; Libby 1995; Gramling and Stone 2000). In this manner, Solomon et al. (1999) provide evidence that industry specialists, compared to non-specialists, have relatively more accurate knowledge of financial statement errors (weakly supported) and non-errors (strongly supported) with respect to firms within their industry specialization. Similar conclusions, particularly with respect to non-error accuracy knowledge, have been indicated when studying an experience-related knowledge differential (e.g., Libby 1985, Kaplan and Reckers 1989; Kaplan et al. 1992).

Other research has also investigated the link between experience, knowledge, and audit judgment. For example, Bedard and Biggs (1991) found that more experienced auditors were better at identifying a seeded error than less experienced auditors. Johnson et al. (1991) reported a positive relationship between industry experience and fraud detection. Wright and Wright (1997) found that industry experience led to greater accuracy in risk assessments and in identifying errors.

The research hypotheses, presented next, are developed using the knowledge acquisition model offered by Libby (1995) and Libby and Luft (1993). That is, we posit that the knowledge differential of IS audit specialists, as compared to financial auditors, with respect to unique ERP system risks is acquired through indirect and direct experience assessing ERP risks and controls. Based on this knowledge differential, we developed study hypotheses.

HYPOTHESIS ONE: HEIGHTENED ERP SYSTEM RISKS

The literature reviewed in this section, as well as three focus group meetings with IS audit specialists (to be described in the next section), suggest that process interdependency risks are greater in an ERP setting than in a non-ERP setting. We would, thus, expect knowledgeable IS audit specialists to assess a higher level of risk for these factors in an ERP environment than a legacy environment. In addition, as a result of the seeded control weakness, we anticipate that security risk (i.e., network, databases, and application) and overall control risk will be higher. To test whether there is greater unique risk exposure in these areas, we examine the following hypothesis, which provides a baseline measure of differential risk assessments (ERP versus non-ERP systems) by IS audit specialists:

H1: Information systems auditors' assessments of the following risks categories will be significantly higher in an ERP setting than a non-ERP setting:

H1a: business interruption risk;
H1b: network security risk;
H1c: database security risk;
H1d: application security risk;
H1e: process interdependency risk; and
H1f: overall internal control risk.

HYPOTHESIS TWO: DIFFERENTIAL RISK ASSESSMENTS

Given the knowledge differential of IS audit specialists and financial auditors with respect to ERP system risks and controls, it is posited that financial auditors will not fully appreciate the extent of the heightened unique risks associated with ERP systems. Insufficient recognition of such risk areas may ultimately impair audit effectiveness, since auditors would not be aware of the need to expand testing or broaden financial statement disclosures. In contrast, it is expected that IS audit specialists, who are experienced in assessing computer systems risks and controls, are aware of the unique risks present in an ERP setting.

In comparing the risk assessments of IS audit specialists to those of financial auditors it is also important to consider potential variations in perspectives. For instance, an IS auditor may have a broader risk focus (e.g., system effectiveness, efficiency, and privacy risks, in addition to financial statement and fraud risk) than a financial auditor, who is most concerned about financial misstatement and fraud. However, it is important to note that the IS auditor participants (to be described further in the next section) were all CPAs and worked with financial auditors on a routine basis. Therefore, they are aware of the focus of the financial auditor, as well as the nature of risk assessments they make (e.g., internal control risk). Further, to the extent that there are differences in the perspectives of IS and financial auditors, the impact of such differences is expected to be constant across computer system environments. Thus, the unique risks posed by

ERP systems, coupled with the specialists knowledge of risks, lead us to posit a greater risk differential between ERP and non-ERP systems for IS audit specialists than for financial auditors. These expectations form the basis for the following multi-part hypothesis:

H2: When comparing the following risk areas between ERP and non-ERP systems, differential risk assessments (ERP minus non-ERP) will be significantly higher for information systems auditors than financial auditors:

H1a: business interruption risk;
H1b: network security risk;
H1c: database security risk;
H1d: application security risk;
H1e: process interdependency risk; and
H1f: overall internal control risk.

The mathematical representation of H2 is as follows:

$$(\mu_{\text{IS Auditor (ERP)}} - \mu_{\text{IS Auditor (non-ERP)}}) > (\mu_{\text{Financial Auditor (ERP)}} - \mu_{\text{Financial Auditor (non-ERP)}}) \quad [1]$$

where μ = Treatment mean of dependent variable of interest

HYPOTHESIS THREE: RECOGNITION OF RISKS ASSOCIATED WITH A SEEDED CONTROL WEAKNESS

In addition to comparing the risk assessments of IS and financial auditors, a second basis of evaluating whether financial auditors recognize unique, heightened risks that may be present in an ERP setting is the extent to which they identify the consequences of a particular seeded control weakness that is expected to have substantially greater impact in an ERP than a non-ERP environment. In an analogous manner, the use of seeded misstatements has been utilized in prior studies to evaluate judgment performance (e.g., Bedard and Biggs 1991; Wright and Wright 1997). Given the limited knowledge of financial auditors of the unique risks of ERP systems, it is expected that they will not recognize the greater impact of a seeded control weakness, leading to our third hypothesis.

H3: Financial auditors will fail to recognize the heightened risks of a particular control weakness that is expected to be greater in an ERP than a non-ERP system environment.

HYPOTHESIS FOUR: CONFIDENCE IN FINANCIAL AUDITORS' RISK ASSESSMENT ABILITY

If, as expected in H2 and H3, financial auditors are not fully aware of the greater risk potential for ERP settings, it is likely that they may be equally confident of their risk assessments in both an ERP and non-ERP environment. As noted, this lack of recognition may result in failing to adequately adapt program plans to the actual level of risks. Additional support for the expectation that auditors may be highly confident in their risk assessments is found in the psychology literature regarding overconfidence (e.g., Klayman et al. 1999; Arkes et al. 1987; Koriat et al. 1980; and Einhorn and Hogarth 1978). This research has shown that experienced individuals are more confident than novices, even when unwarranted by their level of performance (e.g., Mahajan 1992; Christensen-Szalanski and Bushyhead 1981). Although research findings on this issue in auditing are somewhat mixed, the predominant results also support a general tendency of auditors to be overconfident, even when they are outside their range of expertise (e.g., Ahlawat 1999; Moeckel 1990; Moeckel and Plumlee 1989).

In contrast, when IS audit specialists are asked to appraise the ability of financial auditors to assess system risks, we anticipate that IS audit specialists, recognizing the greater complexities of ERP systems, will reflect lower confidence levels in an ERP, as compared to non-ERP, environment. In interpreting this expectation it is likely that IS audit specialists will express a relatively low level of confidence in financial auditors' abilities to assess computer system risks. Klayman et al. (1999) support this expectation, as they reported that individuals tend to be overconfident in their own judgments and under-confident in similar judgments made by others. Further, since IS audit specialists work in a consultative manner, it is likely that a self-serving bias will heighten their belief

that financial auditors need their services. Nonetheless, such a bias, if present, should be a constant across both computer settings. Further, as noted earlier, the participating IS auditors are CPAs and frequently work with financial auditors. Thus, they should have the background to assess their abilities in this regard. Based on the discussion above, the following hypothesis is offered:

> **H4:** When comparing confidence levels regarding the ability of financial auditors to assess computer system risks, differential confidence assessments (ERP versus non-ERP) will be significantly lower for IS audit specialists than for financial auditors.

The mathematical representation for H4 is as follows:

$$(\mu_{\text{IS Auditor (ERP)}} - \mu_{\text{IS Auditor (non-ERP)}}) < (\mu_{\text{Financial Auditor (ERP)}} - \mu_{\text{Financial Auditor (non-ERP)}}) \quad [2]$$

where μ = Confidence level treatment mean

HYPOTHESIS FIVE: PERCEIVED NEED FOR CONSULTATION

The unique risks of an ERP, as compared to non-ERP, computing environment suggest that financial auditors should be more likely to seek consultation of IS audit specialists in an ERP setting. It is well accepted in practice that an auditor cannot possess a high level of knowledge in all areas, which is why specialists are often consulted when needed (Gibbins and Emby 1984). For instance, auditors draw on the expertise of the national office's central research unit on difficult financial reporting issues (Salterio and Denham 1997; Salterio 1996; Salterio 1994) and on actuaries in assessing pension funding and obligations. Further, the psychology literature reveals that consultation is obtained to enhance justification and confidence (Heath and Gonzales 1995). In the audit setting, Kennedy et al. (1997) report that, in an unstructured task, evaluators perceive greater justification for decisions when consultation is obtained. Importantly, there has been no prior study to examine the extent of consultation with IS auditor specialists.

If financial auditors are aware of their limited capabilities or are not confident of their abilities to assess risks in an ERP setting and, accordingly, bring in qualified specialists of the firm, audit effectiveness is unlikely to be compromised. However, as posited by H2-H4, financial auditors are expected to be less than sufficiently knowledgeable of the unique risks posed by an ERP system and highly confident of their risk assessment abilities. These two expectations lead us to predict that financial auditors are unlikely to seek consultation with IS audit specialists.

Further, discussions with IS audit specialists at three of the Big-Five firms indicated that the audit engagement would be assessed an internal charge for the services performed by IS audit specialists. Since the competitive audit environment results in low profit rates, the IS audit specialists suggested that financial auditors' inclination to consult with them is fairly low. The IS audit specialists were quite concerned in this regard, especially since, as discussed previously, they believe that ERP systems pose significantly different risks than non-ERP systems (importantly, all IS specialists consulted were CPAs and thus are familiar with the objectives of an audit and work routinely with financial auditors).

Hence, we expect that IS audit specialists will express a greater need for financial auditors to seek consultation in an ERP, as compared to non-ERP, setting. Once again, it is likely that IS audit specialists across various computer environments will generally believe that there is a greater need for consultation than do financial auditors, because there is a potential self-serving bias present. However, such a bias should be constant between the ERP and non-ERP settings. Accordingly, the final hypothesis is offered (see also formula [1]):

H5: When comparing the perceived need to confer with IS audit specialists, differential assessments (ERP versus non-ERP) will be significantly higher for IS audit specialists than for financial auditors.

RESEARCH METHOD

THE TASK

Auditors were presented with a realistic case (Medical Solutions, Inc.) for a pharmaceutical manufacturer where they were asked to assess risks for a client's computerized systems. The case began with background information on the client, including its size, customers, competitive environment, control environment (good), and the auditing firm's past experiences with the company (positive). A comprehensive business process map was then provided, which was adapted from an industry solutions map developed by SAP, a major ERP vendor. This background information was followed by a description of the computer system as either a non-ERP or ERP environment. The intent was to provide an overall similar level of inherent risk (e.g., industry setting and financial condition) and fraud risk for the two versions of the case. This expectation was borne out by the risk assessments of the participants.[1]

As noted earlier, in addition to comparing the risk assessments of financial auditors to IS audit specialists, a control weakness was seeded into the case. The objective was to identify a weakness that would result in significantly greater risks in the ERP, as compared to non-ERP, setting. A review of the literature, discussed earlier, as well as discussions with IS audit specialists (see below) indicated that a particular area of exposure in an ERP was 'security' risk.

[1] The overall mean assessment of inherent risk was relatively high (m = 6.6, where 1 = low risk; 7 = high risk), most likely due to the pharmaceutical industry setting of the client in the case. ANOVA testing yielded no significant difference for system (F = 0.05, p = .83), and marginally significant differences for auditor type (F = 2.83, p = .09) and the interaction term (F = 3.35, p = .07). Scheffe's multiple pairwise testing (p = .10) indicated no significant differences among treatment means for 'inherent risk' assessments. The overall mean assessment of fraudulent financial reporting risk was near the mid-point of the same seven-point scale (overall m = 3.8). ANOVA testing yielded no significant differences for system type (F = 0.05, p = .83), auditor type (F = 0.01, p = .92), and the interaction term (F = 0.35, p = .55).

Given the interdependent, linked processes in an ERP setting, coupled with the loss of traditional segregation of duties, unauthorized access to the network, databases, and software applications could lead to significant exposure with respect to invalid transactions or errors that may go undetected. Therefore, with the aid of focus groups comprised of IS audit specialists, we developed and seeded the following control and security weakness in the case:

> *Medical Solutions has a client-server computer network, with access to the Internet. A network manager handles computer security throughout the company. The network manager started out with the company 15 years ago. Over the years, he built an outstanding reputation throughout the company as a computer hardware specialist. He was promoted to network manager three years ago. His technical knowledge of Medical Solutions' computer hardware and communication systems is excellent. While most of his day is consumed with handling technical network issues, the network manager is also responsible for the issuance of passwords throughout the entire company. The passwords given to each employee provide access to the company's client-server network and the Internet, as well as to authorized software applications (such as order entry, accounts receivable, accounts payable, etc.). When new employees are hired, the network manager initially establishes their network and application password privileges, and then he shows them how to create their own unique passwords. Employees are allowed to change their passwords (but not their privileges) anytime they desire while employed at Medical Solutions, Inc. Only the network manager can make changes to user privileges, and he only makes such changes when authorized by the users' departmental supervisor.*

The imbedded control weakness is that the network manager has complete control over the issuance and maintenance of passwords. The weakness results in broad access to sensitive information and processes in the computer system, a lack of periodic review of access privileges by supervisors, and passwords not changed on a frequent routine basis. Further, the network manager has no accounting or background knowledge of controls. This weakness is especially of concern in an ERP environment, wherein enterprise-wide information is consolidated into a relational database, business processes are tightly coupled, and improper access or privilege may lead to significant risks and exposures. Stronger access controls would dictate a formal, on-going review of access privileges by a security manager who has no responsibilities over the database

or network. Further, in this ERP setting controls over authorizations are automated. This weakness may result, for instance, in unauthorized individuals (employees or outsiders) who can cause considerable damage if they gain access to the database and to unauthorized transactions that are unlikely to be detected due to automatic triggering of business processes. Although the description of password procedures notes that the network manager can make changes to privileges only when authorized by supervisors, failure to periodically change and review passwords can result in significant security risks. IS audit specialists are expected to recognize this increased risk, whereas less knowledgeable auditors may not, which can lead to false assurance (referred to as a "blind alley" (Johnson et al. 1993, 1991)).

This particular control weakness was chosen based on three focus group meetings with IS audit specialists, each from a different Big-Five CPA firm. The first group included two seniors, four managers, and one partner. The second group included three seniors, three managers and one partner, while the third group included two seniors, four managers and two partners. The IS audit specialists indicated that, while having a network manager control all passwords in a computerized environment is common, it is not advised because the manager is all too often consumed with technical issues and unaware of many of the security issues surrounding the firm's information database, applications, and processes. They further indicated that using network managers in this capacity creates only a moderate level of risk in non-ERP computing environments where processes are largely independent, relational databases are typically not in use, and controls are generally less automated.

PARTICIPANTS

A total of 165 auditors, all CPAs, participated in the study from two large cities in the southeast portion of the United States. Sample demographics are shown on Table 1. Statistical testing indicated no significant differences across experimental conditions (system type or auditor type) on any of the demographic variables, except Computer Information Systems Auditor (CISA) certification and direct experience assessing computer systems and controls. As expected, the group of IS audit specialists had a strong computer systems background. Many of the IS audit specialists were CISA certified (37%) while none of the financial auditors had this certification, and 93% of the IS audit specialists' overall auditing experience was directly related to assessing computer system controls, compared to only 19% for the financial auditors. These differences are significant at $p \leq .01$, thereby supporting the stronger direct experience of the IS auditor specialists.

When asked what percentage of their overall client base uses ERP systems, the proportion was the same for financial and IS audit specialists (36 - 37%), presumably representing the base rate of companies adopting such systems. However, as indicated above, the nature of IS audit work focuses on evaluating computer systems and controls; hence, while working with clients that use ERP systems, IS audit specialists have opportunities to gain narrow, deep experience in assessing the risks and controls surrounding such systems, thereby increasing their direct experiential knowledge of the unique risks posed by ERP systems.[2]

Further support for the knowledge difference of IS audit specialists is found in their differential indirect experience (e.g., education and training). During oral debriefings, the experimenter asked how many participants had taken one or more college courses in IS auditing.

[2] Only six (6) of 82 IS audit specialists (7.3%) indicated that zero-percent of their client base uses ERP systems. The analyses were also performed excluding these six participants and the findings were qualitatively the same.

All 82 IS audit specialists responded in the affirmative, whereas only 6 of the 83 financial auditors had taken a course of this nature. Additionally, participants were asked if they had taken one or more professional training courses in IS auditing (firm sponsored or otherwise). Once again, all IS audit specialists had taken at least one professional training course in IS auditing and none of the financial auditors had participated in such training.

[Insert Table 1 about here]

INDEPENDENT VARIABLES

The study entailed an experiment with two independent variables: system type (ERP vs. non-ERP) and auditor type (financial auditor vs. IS auditor). As recommended when investigating the effect of knowledge differences between experts (specialists) and non-experts (non-specialist), the variable of interest (system type) was manipulated in a between subjects design, while the variable representing 'expertise' (auditor type) was measured (Frederick and Libby 1986; Libby 1995).

Wording of the manipulations for 'system type' is shown in Exhibit 1. Importantly, the ERP system was portrayed as one in which business processes are tightly integrated throughout the company, while the non-ERP system entailed independent business processes with manual controls. A manipulation check (to be discussed) was included in the case to assess whether subjects perceived a higher degree of process interdependencies with an ERP system.

DEPENDENT MEASURES

Based on a review of relevant literature, meetings with focus groups, and development of the seeded control weakness (as described earlier), we identified the following heightened risk categories in the experimental ERP setting: business interruptions, network security, database security, application security, process interdependency, and overall control risk. Based on input

from the IS audit specialists, we developed risk dimensions and scales designed to capture the aforementioned risk categories. After the description of the computer system, auditors were asked a series of questions regarding their risk assessments. Additionally, all participants were asked to record their level of confidence in the ability of the financial auditors to assess computer system risks. Finally, the participating auditors were told that the engagement partner wants their opinion on the necessity of conferring with the practice within the firm that specializes in security and control risks associated with computerized systems before finalizing the audit plan. All of the Big-Five firms have such specialty practices in this regard, for instance, they are referred to as Information Systems Assurance and Advisory Services (ISAAS) at Ernst & Young and Technology Resource Consultants (TRC) at Andersen. Participant responses were recorded on 7 point Likert-type scales with semantic midpoints and anchors.

While it is not possible to definitively establish the actual comparative level of risks for a particular ERP versus non-ERP application, specialization of the IS auditors participating in this study provides them with the requisite expertise and background to recognize the relative risk exposure of each setting. Furthermore, as noted, IS audit specialists work with financial auditors on a routine basis and are aware of financial auditors' abilities to evaluate ERP risks. Therefore, IS auditor consensus responses are utilized as a benchmark.[3] Further, the seeded control weakness serves as a second benchmark to evaluate financial auditor recognition of heightened ERP risks.

[3] A pilot test involving eight financial and seven IS audit specialists representing three of the Big-Five CPA firms was conducted to ensure that the case information was complete and understandable, the manipulation of system type was successful, and the dependent variables (risk factors) and response scales were clear. Pilot test participants included nine managers and six seniors with an average experience of 5.29 years in auditing. All participants were CPAs. Responses to the risk assessment and the manipulation check items strongly supported the success of the ERP versus non-ERP manipulation. Minor changes were made to the background information and the wording of some questions was modified as a result of pilot test responses.

ADMINISTRATION OF THE EXPERIMENT

Our desire was to administer the experiment under controlled conditions. This objective was obtained by conducting the experiment at four continuing professional education (CPE) sessions involving a broad spectrum of auditors with varied financial and IS auditing backgrounds. The topic for each session, SysTrust[SM], was unrelated to ERP systems. However, SysTrust[SM] was chosen as a topic because managing partners of the participating firms felt that this topic would help them to successfully recruit an equal number of financial and IS audit specialists to the sessions, a desirable criteria that the authors made clear *a priori*. One of the authors conducted the CPE sessions, lasting three hours each. Morning and afternoon sessions were held over a contiguous two-day period, resulting in four sessions involving four of the Big-Five CPA firms represented in the sample.

At the end of each session, all auditors volunteered to participate in the study. The experimental treatment conditions (non-ERP versus ERP systems) were randomly distributed to the participants. There were two versions of the study materials for each treatment condition wherein the order of the questions was randomized to preclude an order effect.

RESULTS

MANIPULATION CHECK

The following manipulation check question was included in the study materials as a way to assess the participants' basic understanding of the difference in process and information integration between non-ERP and ERP computer systems:

> *How would you characterize the extent to which enterprise-wide information is integrated throughout the entire organization at Medical Solutions, Inc.? (1 = Not at all Integrated, 4 = Somewhat Integrated, 7 = Totally Integrated).*

An ANOVA model was used to test the manipulation check responses, where the independent variables were system type (ERP versus non-ERP) and auditor type (financial versus IS). The main effect for system type was significant ($F = 188.16$, $p < .01$), as the means (standard deviations) for the ERP and non-ERP conditions were 6.35 (1.01) and 3.56 (1.55), respectively. Neither the main effect for auditor type ($F = 0.01$, $p = .97$) nor the interaction term ($F = 1.58$, $p = .21$) was significant. Thus, the manipulation of system type was considered successful.

RELIABILITY ESTIMATES OF DEPENDENT MEASURES

The development and testing of item wordings and scales were performed in concert with 22 IS audit specialists who comprised three focus group meetings (described above). All items used 7-point Likert-type scales. Some items were reversed scaled. For analysis purposes, all items scales were oriented in the following manner: 1 = very low risk-concern and 7 = very high risk-concern. Item wordings are shown in Exhibit 2 and descriptive statistics are provided in Table 2. Since all reliability estimates were relatively high ($p < .01$), multiple items used to measure risk categories were summed to form risk indices.[4]

[Insert Table 2 about here]

PRELIMINARY TESTING

MANCOVA testing was performed on all dependent measures, where the independent variables were system type (non-ERP versus ERP), auditor type (financial versus IS), CPA firm (four of the Big-Five), and version number (two versions of the case with response measures in different random orders). The covariate represented the percentage of participants' client base with ERP systems (0 to 100). MANCOVA results indicated statistical significance for system type (Rao's $R = 129.65$, $p < .01$), auditor type (Rao's $R = 303.07$, $p < .01$), and the interaction of

[4] Analyses were also conducted using the individual items. The pattern of results was substantially the same as the primary findings reported in the following sections.

system and auditor type (Rao's R = 87.29, $p < .01$). However, neither version (Rao's R = 1.65, $p = .11$) nor CPA firm (Rao's R = 0.60, $p = .95$) were significant. Additionally, interaction terms including version, CPA firm, or both were non-significant (all p-values > .10). The covariate was also non-significant (Rao's R = 1.97, $p = .13$). Accordingly, version, CPA firm, and percentage of ERP client variables were not considered in the upcoming analyses.

UNIQUE ERP SYSTEM RISKS (H1)

The first hypothesis posits that IS audit specialists will assess significantly higher risks in the ERP, as compared to the non-ERP, experimental setting. To test this assertion, IS audit specialists' mean responses to each risk category were compared between system types (ERP and non-ERP). As shown in Table 3, mean risk assessments in all categories were significantly higher in the ERP condition. These results establish baseline measures indicating that domain specialists (IS audit specialists) perceive ERP systems to be riskier than non-ERP systems in the assessed risk areas. Accordingly, the first hypothesis is supported.

[Insert Table 3 about here]

DIFFERENTIAL RISK ASSESSMENTS (H2)

The second hypothesis indicates that differential risk assessments between ERP and non-ERP systems will be significantly higher for information systems auditors than financial auditors. To test this assertion, ERP and non-ERP risk indices were subtracted for each risk category, and mean difference scores were tested between IS and financial auditors (see formula [1]). As indicated in table 4, differential risk assessments of IS audit specialists were significantly higher than financial auditors in all risk categories. Accordingly, the second hypothesis was supported.

[Insert table 4 about here]

RECOGNITION OF RISKS ASSOCIATED WITH A SEEDED CONTROL WEAKNESS (**H3**)

H3 posits that financial auditors will not recognize the greater risks associated with the seeded control weakness in the ERP setting than the non-ERP setting. Specifically, the control weakness relating to the control over passwords by the network security manager is anticipated to lead to higher security risks in the ERP environment, as described earlier. The pairwise comparisons in Table 4 (shaded in gray) show that for all three security risk factors (network, database, and application security) there is no significant difference in financial auditors' risk assessments for the ERP versus the non-ERP case manipulations. These results support H3.

FINANCIAL AUDITORS' ABILITY TO ASSESS COMPUTER SYSTEM RISKS (H4)

To examine H4, we asked the participating auditors their beliefs regarding the qualifications of the financial audit team to assess the internal controls over the case company's network, database, and application security. A fourth response item assessed the extent to which participants believed that the financial audit team was capable of properly assessing the firm's risk exposure related to computerized applications. As discussed previously (see Table 2), these four items were summed to form a 'confidence' index, where lower scores indicate less confidence in the financial auditors' qualifications to assess such risks.

The ANOVA model yielded significant effects for system type ($F = 407.95$, $p < .01$), auditor type ($F = 906.68$, $p < .01$) and the interaction term ($F = 392.84$, $p < .01$). Treatment means were as follows: 7.58 (IS auditor by ERP system), 21.90 (IS auditor by non-ERP system), 25.45 (Financial auditor by ERP system), and 25.59 (Financial auditor by non-ERP system). The planned contrast (see formula [2]) was significant ($F = 1226.43$, $p < .02$). Also, Scheffe's multiple pairwise comparison ($\alpha = .05$) indicated that the IS auditor treatment means (7.58 and

21.90) were significantly different from all other means, but the financial auditor treatment means (25.45 and 25.59) were not significantly different from each other.

Overall, the IS audit specialists' mean assessment of the financial auditors' qualifications to assess risk in a non-ERP environment was relatively high, while this assessment in an ERP environment was quite low. However, financial auditors believed that they were equally qualified to assess computer system risks in both environments. It is recognized that the IS audit specialists likely have a self-serving bias with respect to this assessment, since their livelihood is partially dependent on consultation engagements with financial auditors; nevertheless, the specialists assessed the financial auditors' qualifications to evaluate computer system risks in a non-ERP environment as quite high (m = 21.90). If the self-serving bias was overwhelmingly strong and pervasive, one might expect the IS audit specialists to assess the financial auditors' qualifications across both computer environments to be low. Thus, there is some indication that the IS audit specialists' responses were not blindly influenced by a self-serving bias. Based on the study results, the fourth hypothesis was supported.

Perceived Need for Consultation (H5)

The final hypothesis (H5) examines the extent to which financial auditors are inclined to request the services of IS audit specialists. Due to the unique risks posed by ERP systems, we anticipated that IS audit specialists would assess the perceived need for such consultation to be higher in the ERP, as compared to the non-ERP, condition. However, if the financial auditors do not recognize the unique risks of ERP systems, they would express similar perceived consultation needs in both system conditions. Hence, the differential assessments (ERP minus non-ERP) are expected to be higher for IS audit specialists than financial auditors (see formula [1]).

The ANOVA model indicated significant effects for system type ($F = 13.15$, $p < .01$), auditor type ($F = 186.99$, $p < .01$), and the interaction term ($F = 4.36$, $p < .04$). Treatment means were as follow: 6.35 (IS auditor by ERP system), 4.90 (IS auditor by non-ERP), 2.36 (Financial auditor by ERP system), and 1.97 (Financial auditor by non-ERP system). The planned contrast (see formula [1]) was significant ($F = 187.86$, $p < .01$). Additionally, Scheffe's multiple pairwise comparison ($\alpha = .05$) indicated that the IS auditor treatment means (6.35 and 4.90) were significantly different from all other treatment means, but the financial auditor treatment means (2.36 and 1.97) were not significantly different from each other. Based on statistical test results, the fifth hypothesis is supported.

Additional Findings From Supplemental Survey

Financial auditors' assessments of their level of confidence (H4) and the need for consultation (H5) may be based on assumptions about whether IS audit specialists would be routinely involved in assessing controls for ERP clients as a standard firm practice. This assumption might explain the findings reported previously, which indicate a high level of confidence and low perceived need for consultation. To evaluate this possibility, a post-experiment, supplemental survey was sent to four Big-Five firms and an international consulting firm. The resulting sample of 106 respondents (71% response rate) was comprised of 58 financial auditors, 22 IS auditors, and 26 consultants (with direct experience working with ERP systems). Respondents included 11 partners, 32 managers, 36 seniors, and 27 staff. Wording of the supplemental survey questions are shown on Table 5, as are the results. The findings indicate a relatively low base rate where IS auditors were consulted, ranging from a high of 20% of audit engagements to only 4%. Importantly, for recurring engagements (the setting of the experimental case), financial auditors indicated they believed only in about 13% of audits would IS auditors be

consulted in an ERP environment. Thus, the results of the hypotheses tests are not likely to be attributable to a presumption by participants that consultation had taken place.

[Insert Table 5 about here]

DISCUSSION

The purpose of this study was to understand and assess business and audit risk differences between traditional computer "legacy" systems and enterprise resource planning (ERP) systems, as reflected by financial auditors and information systems (IS) audit specialists. Our review of the literature and discussion with three focus groups of IS audit specialists revealed that ERP systems may pose at least the following elevated risk concerns: business interruptions, network security, database security, application security, and process interdependency.

The research findings indicate that financial auditors may not be fully aware of the greater exposure of unique risks in an ERP setting as compared to a traditional computer environment. The results also suggest that financial auditors do not fully recognize the risks associated with interdependencies among business processes in an ERP environment. Further, the findings relating to a seeded control weakness, where a technical network manager has complete control over the issuance and maintenance of passwords, indicate that financial auditors do not recognize the greater risks associated with poor password controls in an ERP context. Of concern, the findings also reveal a high level of confidence by financial auditors in assessing risks in both the traditional (non-ERP) and ERP settings, as well as a reluctance to seek the consultation of IS audit specialists. Overall, the findings suggest a lack of understanding and consideration of unique ERP risks by financial auditors, which could have deleterious effects on audit quality.

In interpreting the findings, it is important to consider potential limitations of this study. There are no normative benchmarks available to determine the level of risks for the ERP and non-ERP settings examined. Consistent with prior research (e.g., Bedard and Biggs 1991; Solomon et al. 1999; Wright 1988), we use surrogate benchmarks: the judgments of experts in the field (IS audit specialists) and the seeding of a control weakness. Further, while the risk dimensions selected were identified from the literature, focus group discussions with IS audit specialists, and empirical testing of IS auditor risk assessments, we do not suggest that these dimensions reflect a comprehensive identification of the unique risks posed by ERP systems. Given the early state of the research in this area, we believe our experimental approach is appropriate. However, future empirical research is needed to more fully identify and assess the nature of the risks and potential problems (e.g., errors, fraud, business interruption) associated with ERP systems.

Future research is also needed to more fully understand factors that may lead to potential over-confidence by financial auditors in assessing risks in an ERP environment and their reluctance to seek expert consultation. Preliminary discussions with eight financial auditors from three of the Big-Five firms in the pilot test suggested that economic self-interests may lead to a predisposition to avoid consultation, because they would have to hire the services of IS audit specialists, increasing the cost of the audit. Further, IS audit specialists were a bit resentful that financial auditors do not appear to recognize and respect their skills. Both IS and financial auditors expressed a great deal of intra-firm tension on this issue. A fruitful avenue for future research is to more fully examine these potential organizational conflicts and ways to mitigate them to better accomplish audit objectives.

Exhibit 1

Manipulations for Nature of the Computer System

Non-ERP system:

The computerized accounting system used by Medical Solutions, Inc. includes general ledger, accounts receivable, accounts payable, joint venture accounting, cash management, payroll, fixed assets, and various cost/managerial accounting applications. The accounting system applications at Medical Solutions are integrated with each other, as are the computerized applications within each business process category. However, company information is not integrated across the company's business processes, as databases for each process are maintained separately. Thus, workflow procedures across business processes are, for the most part, performed manually. For example, when a customer places an order (face-to-face with a salesperson, over the telephone, or via the Internet) with Medical Solutions, the following events take place:

1) a sales person enters the customer order in the sales order system (SOS),
2) the salesperson notifies customer relationship management (CRM) of the order,
3) a CRM employee records the order in the CRM system,
4) the sales person notifies accounting of the order,
5) an accounting employee records the sale in the accounting system,
6) the sales person notifies the warehouse of the order,
7) a warehouse employee records the order in the warehouse management system (WMS),
8) the warehouse employee notifies packing & shipping of the order,
9) a shipping employee records the order in the packing & shipping system (PSS),
10) the shipping employee notifies procurement of the order,
11) a procurement employee records an order for replacement raw materials in the procurement management system (PMS),
12) the procurement employee notifies production of the need to replenish the sold goods, and
13) a production employee records a manufacturing order in the production planning system).

Exhibit 1 (continued)
Manipulations for Nature of the Computer System

ERP System:

The computerized accounting system used by Medical Solutions, Inc. includes general ledger, accounts receivable, accounts payable, joint venture accounting, cash management, payroll, fixed assets, and various cost/managerial accounting applications. The accounting system applications at Medical Solutions are integrated with each other, as are the computerized applications within each business process category . Also, company information is integrated throughout the company's business processes via an enterprise resource planning (ERP) system that is built on a relational database. Thus, workflow procedures across business processes are, for the most part, performed automatically. For example, when a customer places an order (face-to-face with a salesperson, over the telephone, or via the Internet) with Medical Solutions, the ERP automatically executes the following events:

1) a sales person enters the customer order in the sales order system (SOS),
2) the SOS notifies customer relationship management (CRM) of the order,
3) the SOS records the order in the CRM system,
4) the SOS notifies accounting of the order,
5) the SOS records the sale in the accounting system,
6) the SOS notifies the warehouse of the order,
7) the SOS records the order in the warehouse management system (WMS),
8) the WMS notifies packing & shipping of the order,
9) the WMS records the order in the packing & shipping system (PSS),
10) the PSS notifies procurement of the order,
11) the PSS records an order for replacement raw materials in the procurement management system (PMS),
12) the PMS notifies production of the need to replenish the sold goods, and
13) the PMS enters a manufacturing order in the production planning system (PSS).

Exhibit 2

Wording of Dependent Variable Items

Business Interruption Risk

How concerned are you about material, negative financial consequences of business interruptions that could occur at Medical Solutions due to computer systems problems? (1 = Very Unconcerned, 7 = Very Concerned)

How concerned are you that Medical Solutions could experience a major business interruption due to computer systems problems? (1 = Very Unconcerned, 7 = Very Concerned)

Network Security Risk

How concerned are you that outside intruders (hackers) can get into Medical Solution's computer network and perform illegal activities, such as stealing company information or planting computer viruses? (1 = Very Unconcerned, 7 = Very Concerned)

How concerned are you that Medical Solution's employees can get into the computer network and perform illegal activities, such as stealing company information or planting computer viruses? (1 = Very Unconcerned, 7 = Very Concerned)

I believe that the current situation of having a network security manager provides a secure firm-wide network environment. (1 = Totally Disagree, 7 = Totally Agree)

Database Security Risk

How concerned are you that outside intruders can gain unauthorized access to highly proprietary computerized information at Medical Solutions, Inc.? (1 = Very Unconcerned, 7 = Very Concerned)

How concerned are you that employees can gain unauthorized access to highly proprietary computerized information at Medical Solutions, Inc.? (1 = Very Unconcerned, 7 = Very Concerned)

I believe that the current situation of having a network security manager provides a secure firm-wide information environment. (1 = Totally Disagree, 7 = Totally Agree)

Application Security Risk

How concerned are you that employees can legitimately gain entry into software applications and then be able to view unauthorized information at Medical Solution's? (1 = Very Unconcerned, 7 = Very Concerned)

I am satisfied with the way in which application passwords are issued and controlled at Medical Solutions. (1 = Totally Disagree, 7 = Totally Agree).

Process Interdependency Risk

How concerned are you that a problem in one business process (e.g., an improperly input customer sales order) will lead to problems in other processes? (1 = Very Unconcerned, 7 = Very Concerned)

I believe there are sufficient controls to prevent a problem in one business process from affecting other processes? (1 = Totally Disagree, 7 = Totally Agree)

Exhibit 2 (Continued)

Wording of Dependent Variable Items

Control Risk

CONTROL RISK is defined as the risk that the client's controls will fail to prevent or detect material misstatements (SAS 55 & 78). Provide an assessment of the CONTROL RISK associated with the accounting system applications of Medical Solutions by circling the appropriate number on the scale below: (1 = Low Risk, 7 = High Risk)

Confidence in Financial Auditor's Risk Assessment Ability

I believe that members of the financial audit team are qualified to assess the internal controls over Medical Solution's computer network security. (1 = Totally Disagree, 7 = Totally Agree)

I believe that members of the financial audit team are qualified to assess the internal controls over Medical Solution's data files. (1 = Totally Disagree, 7 = Totally Agree)

I believe that members of the financial audit team are qualified to assess the internal controls over Medical Solution's computerized application security. (1 = Totally Disagree, 7 = Totally Agree)

Assume that the engagement partner wants your opinion concerning the ability of the financial audit team to properly consider the firm's exposure in addressing the risks that may be present with the computerized applications at Medical Solutions. On the scale below, please circle your level of confidence that the financial audit team is capable of assessing the audit risks associated with the computer systems used at Medical Solutions. (1 = Very Low Confidence, 7 = Very High Confidence)

Perceived Need for Consultation

The engagement partner also wants your opinion with respect to the necessity of conferring with the practice within your CPA firm that specializes in security and control risks associated with computerized systems. Given the need for efficient audits, such specialists are not consulted on every engagement, but rather when the engagement team believes the audit program may not reduce audit risk to a tolerable level. Please provide your assessment of the necessity to consult with your CPA firm's computer specialists before finalizing the audit plan for Medical Solutions by circling the appropriate number below. (1 = Absolutely Unnecessary, 7 = Absolutely Necessary)

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Table 1: Sample Demographics

Sample Size	165
Big-Five Firm	
CPA Firm One	41
CPA Firm Two	39
CPA Firm Three	51
CPA Firm Four	34
Auditor Type	
Financial	83
Information Systems	82
Experimental Condition	
Traditional System x Financial Auditor	39
Traditional System x Information Systems Auditor	42
ERP System x Financial Auditor	44
ERP System x Information Systems Auditor	40

Demographic Data

Position Level	Financial	IS	Total
Staff	10	6	16
Senior	35	39	74
Manager	33	31	64
Partner	5	6	11
Certification			
CPA	83	82	165
CIA	7	10	17
CFE	3	5	8
CISA	0	31	31

	Financial	IS	Total	*t*	*p*
Mean years auditing experience	5.51	5.46	5.48	0.08	0.94
Mean years of college education	5.28	5.37	5.32	1.21	0.23
Audit experience (%) in Pharmaceuticals Industry	15.60	14.45	15.03	0.43	0.67
Audit experience (%) directly assessing computer system controls	18.67	92.68	55.45	46.32	0.01
Client-base (%) with ERP systems	37.35	36.22	36.78	0.29	0.77

Chi-square tests of proportions, *t* tests, and ANOVA models indicate no significant differences across treatment conditions on any of the demographic variables (all p-values exceeded .23), with the exception of (1) CISA certification ($p < .01$) and (2) overall audit experience assessing computer system controls ($p < .01$).

Table 2: Descriptive Statistics for Dependent Measures

Dependent Variable	Number of Items	Reliability Estimate*	Mean	Standard Deviation	Low+	High+
Business Interruption Risk	2	.50	6.45	3.78	2	14
Network Security Risk	3	.75	11.83	5.56	3	21
Database Security Risk	3	.82	10.52	6.01	3	21
Application Security Risk	2	.64	6.78	4.23	2	14
Process Interdependency Risk	2	.53	7.08	3.96	2	14
Confidence in Financial Auditors	4	.88	20.25	7.69	4	28
Need for Consultation	1	n/a	3.88	2.41	1	7

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* For two item indices, reliability estimates are assessed via Pearson Correlation (r). For three or more item indices, reliability estimates are indicated by standardized Cronbach α, adjusted for number of items in the index. All reliability estimates are significant ($p < .01$).

+ The range of responses also reflects the maximum theoretical range for all of the dependent variables.

Table 3: Tests of H1

Mean Responses by Risk Category for IS Audit Specialists

Risk Category	ERP System *Mean (S.D.)	Non-ERP System *Mean (S.D.)	*t*-statistic	*p*-value
Business Interruption Risk (H1a)	11.50 (2.06)	3.52 (1.76)	18.88	.01
Network Security Risk (H1b)	19.63 (1.76)	13.19 (2.12)	14.90	.01
Database Security Risk (H1c)	19.28 (1.91)	10.92 (2.68)	16.17	.01
Application Security Risk (H1d)	13.08 (2.19)	6.62 (2.27)	16.25	.01
Process Interdependency Risk (H1e)	12.85 (2.02)	6.48 (2.13)	13.88	.01
Internal Control Risk (H1f)	6.43 (0.55)	3.48 (1.57)	10.80	.01

* Higher means indicate greater perceived risk by IS audit specialists

Note 1: Obtained results were not significantly different when the IS audit specialists were subdivided into those with and without the CISA certification.

Note 2: Obtained results were not significantly different when IS audit specialists were subdivided into (1) those above and below the mean percentage clients (36.22%) with ERP systems or (2) those in the upper and lower quartiles based on the percentage clients with ERP systems.

Table 4: Tests of H2 and H3

Planned Contrast Test Results

Dependent Variable	($\mu_{\text{IS Auditor (ERP)}}$ - $\mu_{\text{IS Auditor (non-ERP)}}$)		($\mu_{\text{Financial Auditor (ERP)}}$ - $\mu_{\text{Financial Auditor (non-ERP)}}$)	F	p-value	
Business Interruption Risk (H2a)	(11.50^{a} - 3.52^{b})	>	(6.95^{c} - 3.84^{b})	75.35	.01	
**Network Security Risk (H2b)	(19.63^{a} - 13.19^{b})	>	(7.50^{c} - 7.25^{c})	663.13	.01	
**Database Security Risk (H2c)	(19.28^{a} - 10.92^{b})	>	(6.14^{c} - 6.05^{c})	533.85	.01	H3
**Application Security Risk (H2d)	(13.08^{a} - 6.62^{b})	>	(3.59^{c} - 4.13^{c})	488.30	.01	
Process Interdependency Risk (H2e)	(12.85^{a} - 6.48^{b})	>	(5.64^{b} - 3.44^{c})	334.30	.01	
Internal Control Risk (H2e)	(6.43^{a} - 3.48^{b})	>	(3.84^{b} - 1.97^{c})	185.10	.01	

* Higher means indicate greater perceived risk
** Risks related to the seeded control weakness

Note 1: The planned contrasts (above) were determined from ANOVA models where the independent variables were system type (ERP and non-ERP) and auditor type (Information System and Financial). Main effects and interaction terms were significant ($\alpha < .05$) for all ANOVA models. Also, Scheffe's multiple pairwise comparison tests ($\alpha = .05$) were conducted for each dependent variable yielding consistent results with the planned contrasts. Specifically, reading across the rows, means with different superscripts indicate significant differences using Scheffe's test. For instance, regarding business interruption risk, 11.50 and 6.95 are significantly different from all other treatment means, whereas 3.52 and 3.84 are not significantly different from each other.

Note 2: Obtained results were not substantially different when the IS audit specialists were subdivided into those with and without the CISA certification.

Note 3: Obtained results were not significantly different when IS audit specialists were subdivided into (1) those above and below the mean percentage clients (36.22%) with ERP systems or (2) those in the upper and lower quartiles based on the percentage clients with ERP systems.

Table 5

Supplemental Survey Findings

Survey Question [1, 2]	Financial	IS Spec.	Consultant	F	*p*
1. Pre-Implementation Consultation	20.43[a]	15.45[b]	11.35[c]	17.59	.01
2. Post-Implementation Consultation	12.72[a]	6.78[b]	4.04[c]	34.24	.01
3. Integral Part of the Audit Team	11.24[a]	9.91[a,b]	7.58[c]	3.57	.03

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[1] The questions in the survey were:

1. When one of your audit clients implements an ERP system how often do you (or someone else on the audit engagement) bring in IS audit specialists within your firm to consult with in order to assess control risks? (Percentage of time)

2. For audit engagements after an ERP system is implemented how often do you (or someone else on the audit engagement) bring in IS audit specialists within your firm to consult with in order to assess control risks? (Percentage of time)

3. How frequently do you believe an IS audit specialist is an integral part of the financial audit team for an ERP client setting. (Percentage of time)?

[2] Higher means indicate greater confidence.

Note 1: Scheffe's multiple pairwise comparison tests ($\alpha = .05$) were conducted for each dependent variable yielding consistent results with the planned contrasts. Specifically, reading across the rows, means with different superscripts indicate significant differences using Scheffe's test.