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The Effects of Information Overload on Software Project Risk Assessment*

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ABSTRACT

Managers are responsible for providing effective information technology governance of the software development process. Ineffective governance leads to serious resource misallocations and negative consequences concerning Sarbanes-Oxley compliance. In order for managers to make informed decisions about software development projects, they often need more information than is available through normal information channels, that is, they need an in-depth review of the at-risk project. Such in-depth reviews, however, are costly. Hence, accurate identification of at-risk projects for in-depth review is critical to management's ability to govern. This research considers how two factors, information load and time pressure, affect the quality of the project-selection process. We examine quality by observing the decision strategies involved and then relating these strategies to subsequent decision making. An experiment was conducted with experienced information systems auditors using a combination of policy-capturing and computerized process-tracing techniques. The participants in our study cope with information overload by accelerating their decision-making process and adopting noncompensatory decision processes. Contrary to prior research, our process-tracing analysis suggests that participants rarely filter information, thus implying that decision makers are unable to process all the information. Coping by resorting to noncompensatory strategies did not decrease decision quality unless combined with accelerated information processing. Participants also increase their weight on the software project risk factors that they repeatedly access and that they view for longer periods of time. The theoretical contributions and practical implications regarding what actions managers can take to reduce the negative impact of information overload are discussed.

Subject Areas: Computerized Process Tracing, Decision Strategy, IT Governance, Information Overload, Information Processing, Policy Capturing, Risk Judgments, and Software Project Risk.

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INTRODUCTION

In today's business environment, effective governance of information technology (IT) is a critical managerial function (Berghel, 2005). Furthermore, management involvement in information system (IS) development is recognized as a key factor in the success of IT projects (Keil & Mann, 1997; Keil, Cule, Lyytinen, & Schmidt, 1998; Wallace, Keil, & Rai, 2004a). One significant IT governance activity relates to the problem of identifying at-risk IS development projects in a timely and effective manner. Recent studies report that 30%–72% of all IS projects experience schedule and cost overruns (Keil, Mann, & Rai, 2000; Schmidt, Lyytinen, Keil, & Cule, 2001; Hettigei, 2005). On average, these projects are more than 150% over budget and/or behind schedule. Of these projects that are ultimately completed, auditors evaluate less than 25% to be successful (Keil & Mann, 1997). In sum, managers allocate significant resources to at-risk IS development projects despite substantial cost and schedule overruns. This research considers what managers can do to help identify at-risk IS development projects in order to correct their problems.

To mitigate the incidence and impact of runaway projects, organizations conduct independent reviews of their IT projects (Hettigei, 2005). IS auditors spend an average of 15.6% of their time monitoring IS projects (Keil & Mann, 1997). Audit deliverables include identification of project risks and project continuance recommendations to management along with overall assessments of the project (Hettigei, 2005). Managers use the information provided by IS auditors to make important resource allocation decisions, and IS auditors are viewed as important sources of information to managers about troubled software projects because of their perceived objectivity (Keil et al., 2000). Thus organizations can benefit by understanding the decision processes and factors that affect the quality of IT project-review selection decisions.

IT governance activities, such as obtaining risk assessments related to system project development, will likely increase in importance with the additional requirements of the Sarbanes-Oxley Act of 2002 (Brown & Nasuti, 2005). For instance, in the past, organizations have not tended to extend their fiduciary responsibility over corporate assets to include software development projects. Armour (2005) points out, however, that deficiencies in developing and maintaining systems has serious consequences concerning Sarbanes-Oxley compliance, a top management concern. Thus, the risk assessment and review of software development projects is an area of growing importance as evidenced by the current high demand for IT professionals specializing in audit (Expansion Management, 2005).

Consistent with contemporary IT governance risk–based approaches (ITGI, 2007), we depict the task of selecting an IS project for in-depth review as one in which the decision maker evaluates various risk factors to determine whether the overall project risk warrants selection. Ideally, the highest risk projects are selected for review. Thus, it is important that the decision maker accurately combine the various dimensions of project risk into an accurate overall assessment. This, however, is no easy task as there are numerous well-documented project risk factors, including factors involving human resources such as the sufficiency of management involvement, project team expertise, and user involvement, as well as factors

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involving budget and schedule data and so on (Keil & Mann, 1997; Keil et al., 1998; Wallace et al., 2004a). Prior research documents that quality in decisions often deteriorates when the task is information intensive and information overload is present (Schick, Gordon, & Haka, 1990; Stocks & Harrell, 1995).

Empirical research in the software project management literature has categorized sources and types of risks, developed checklists, proposed frameworks and risk dimensions, and focused on how risk is perceived by project managers (Barki, Rivard, & Talbot, 1993; Keil et al., 1998; Schmidt et al., 2001; Wallace & Keil, 2004; Wallace et al., 2004a; Wallace, Keil, & Rai, 2004b). Other research has surveyed IS auditors and professionals to collect information about software project escalation in order to develop and test predictive models of escalation (Keil et al., 2000; Keil, Rai, Mann, & Zhang, 2003; Zhang, Keil, Rai, & Mann, 2003). An important but lacking area of this literature is an understanding of how software development risk factors are used to make decisions about selecting projects for in-depth review—the critical event within the IT governance monitoring function over software development. This study directly investigates the information processing associated with the project selection decision.

The main premise investigated by this study is that, when decision makers become overloaded because of increased organizational pressures on their time and the many risk factors they must consider, they cope by changing their decision strategy. Their coping strategies are hypothesized to differentially affect software development project monitoring decisions. Hence, we analyze the decision strategy of experienced IS auditors and test its effects on project selection decisions when overload conditions are present. As such, we examine the intermediate step of information processing leading to the decision of selecting IT projects to review and how the quality of the review is affected by organizational and environmental pressures.

The present study contributes to the existing IT governance literature in several ways. First, managers make resource allocation decisions, such as which projects to review, fund, or discontinue. Thus research that helps managers understand the decision process better is beneficial in order to use these resources more productively (Field, Ritzman, Safizadeh, & Downing, 2006). Managers also benefit from understanding the effects of organizational factors, such as time pressure and information load, on decisions that affect IT governance. In addition, managers need to know when a project is in trouble and they need to understand the factors that influence how these projects are identified. Having this understanding should lead managers to develop decision aids or make other adjustments to correct the organizational and environmental pressures that lead to lower-quality decisions. Second, the study extends the basic information overload literature to an important context (i.e., software development)—as previously mentioned, an area that has significant implications for managerial decision making. This extension is facilitated by integrating the IS, accounting, and psychology literatures concerning information overload with information processing theories in order to gain a complete understanding of the concepts. Third, by examining the effects of different coping strategies on a variety of judgment measures, this study reveals the differing effects that occur based on which coping strategy is used.

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A fourth, methodological contribution is that this study combines computerized process tracing and policy capturing into a single information overload study. Computerized process tracing aids understanding of how a task is completed and provides a foundation for decision support system (DSS) development (Cook & Swain, 1993). Policy capturing uses linear models to estimate the decision model of an individual decision maker (Cooksey, 1996). By combining the two methods, we are able to determine both how projects are selected (using process tracing) and why (using policy capturing). Furthermore, this combination of methods allows an examination of information overload effects on both (i) how decision makers change their information processing and (ii) how these changes are reflected in their decisions. It also permits an examination of how information processing and decisions relate to each other in an IT governance context. For example, computerized process-tracing measures, such as the amount of time that decision makers spend acquiring information, are expected to affect their decision quality on measures such as information usage and risk factor importance. Managerial decision making and IT governance are directly impacted by project risk information and, therefore, should benefit from understanding both the information processing involved in selecting at-risk projects for in-depth audit and the factors that negatively impact the decision making.

The remainder of this study is organized as follows: The next section consists of the theory and hypotheses development. It describes information overload and how information processing affects judgment and is followed by information overload effects on decision making. The experimental method section is next followed by the data analysis and results. The last section concludes with a discussion of the findings and implications for theory and practice.

THEORY AND HYPOTHESES DEVELOPMENT

Information Overload

Information overload is a multidisciplinary phenomenon affecting the human information processing of individuals, groups, organizations, and society (Grisé & Gallupe, 2000). Various disciplines approach information overload from somewhat different perspectives; thus, it is important to consider the contributions of each discipline in order to thoroughly understand the phenomenon. Findings across disciplines indicate that information overload stems from two fundamental variables, one pertaining to the information-processing capacity of the decision maker and the other related to the information-processing requirements of the task (Eppler & Mengis, 2004).

Information overload occurs when information-processing demands exceed the individual's capacity to process the information within the time available (Schick et al., 1990). As such, information overload results from a combination of too much information within a constrained amount of time. This definition views information processing capacity as the amount of information that can be processed per unit of time rather than the total amount of information that must be processed. New IT governance demands and increasing system complexity, such as value

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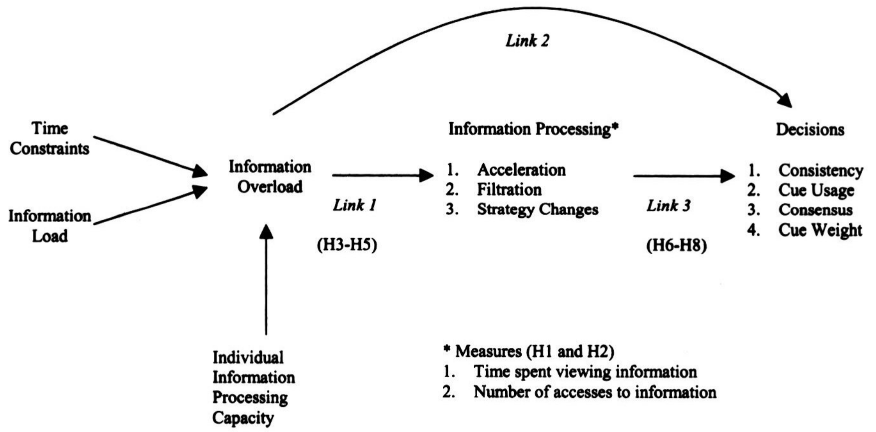
Figure 1: Conceptual model.



chain integration and enterprise-wide databases, are likely to create information overload conditions for individuals who monitor IS performance and quality.

Research shows that information overload can lead to less information being used (Lusk, 1993; Tuttle & Burton, 1999; Burton & Tuttle, 2002), less information being searched, increases in the variability in search patterns (Swain & Haka, 2000), limited search directions, changes in search patterns (Cook, 1993), and selective search patterns (Hiltz & Turoff, 1985). Such negative effects could seriously impair system project risk assessments and lend support to the idea that information overload will decrease the effectiveness of IS auditors' project-selection decisions. To the extent that this occurs, the effectiveness of IT governance is undermined.

Figure 1 depicts the theoretical relationships between time constraints, information load, and processing capacity leading to information overload, which in turn affects information processing. Link 1 between information overload and information-processing coping strategies is established in the psychology literature and is described in the section on coping strategies. Link 2 between information overload and decisions has been tested in applied settings and does not consider the intermediate step that occurs with information processing but, rather, treats information processing as a "black box." Link 3, the effects of specific information-processing coping strategies on decisions, has not previously been tested and is described in the section on the effects of information processing on the IS project-selection decision. The next section describes the general relationship between information processing and judgment that provides a basis for understanding all three links.

Information Processing

To understand how information-processing coping strategies affect decisions, it is first helpful to consider the relationship between information-processing measures, such as the time spent viewing information, and judgment. Wedell and Senter (1997) propose a theory in which the weight given to a piece of information in a

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judgment corresponds to the amount of processing that the information receives. They describe the relationship between information processing and judgment in three ways: continual, discrete, and strategic information sampling.

With continual information sampling, the weight given to a piece of information in a subsequent judgment is related to the amount of time spent accessing or acquiring that information. That is, the longer a piece of information is viewed by a decision maker, the greater weight that piece of information will likely be given in a subsequent judgment. Wedell and Senter (1997) support their continual sampling theory in an experiment in which college students judged the likelihood that various majors would succeed on the basis of verbal and math aptitude scores. By tracking time per acquisition (VIEWTIME) for each piece of information, they found that the students subsequently gave more weight to the information which they had spent more time viewing. This suggests that the amount of time an IS auditor spends on each project risk factor will influence the weight that the auditor subsequently places on that factor in his or her selection decision.

Continual information sampling theory has implications for the quality of IS auditor decisions in that the amount of time that an IS auditor spends with a specific risk factor is not necessarily correlated with the true importance of that factor. In fact, an IS auditor may spend more time with a factor that is less familiar, more complex, or ambiguous and less time with risk factors for which its implications are readily apparent and clear. Furthermore, IS auditors who experience information overload as a result of time pressure are likely to adjust the amount of time spent with information. Hence, continual sampling theory is particularly relevant to IT risk assessment decisions and to the issue of how IS auditors react to information overload. We therefore propose the following hypothesis to test continual sampling theory:

> *H1: Compared to risk factors with which they had spent less time, auditors will place greater weight in their decision on risk factors with which they had spent more time when selecting IS projects for review.*

In contrast to continual sampling theory, the theory of discrete information sampling asserts that the more often a piece of information is accessed, the greater will be its weight in a subsequent judgment. Studies that monitor eye movement have shown that individuals tend to access the most important information more frequently than less important information (Duffy & Rayner, 1990; Rayner & Morris, 1990; Hegarty, 1992). Wedell and Senter (1997) support discrete information sampling theory by tracking the frequency that information is accessed and relating these to the subsequent judgments of their student subjects. Discrete information sampling theory is important to systems project risk assessments, because the conditions leading to information overload are likely to affect the number of times an IS auditor returns to reprocess any one piece of information. Discrete sampling theory suggests the following hypothesis:

> *H2: When selecting IS projects for review, auditors will place greater weight in their decisions on risk factors that they have more frequently accessed.*

Wedell and Senter's (1997) third theory of sampling involves selectively processing information based on its importance. Because selectively processing

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certain information while ignoring other information is the same process as a specific strategy for coping with information overload (i.e., filtration), its effects on decisions will be discussed in the next section describing coping strategies.

Coping Strategies

A limited amount of research exists with regard to how individuals cope with information overload. Most applied studies focus on coping behaviors that limit information search and on retrieval strategies that reduce the information load but do not consider potential time constraints (Cook, 1993; Swain & Haka, 2000; Eppler & Mengis, 2004; Jones, Ravid, & Rafaeli, 2004). Psychology research goes deeper to describe a hierarchy of strategies used by decision makers to cope with both time pressure and cognitive constraints associated with information overload. Three strategies are noted, beginning with (i) accelerated processing of information, followed by (ii) selectively processing or filtering information (filtration), and, finally, (iii) shifting to less demanding decision models that are noncompensatory (Maule & Hockey, 1993; Payne, Bettman, & Johnson, 1993; Payne, Bettman, Johnson, & Luce, 1995; Maule & Edland, 1997). The first coping strategy—accelerate processing—addresses the time aspect of information overload whereas the second coping strategy—filter out less important information—addresses the information load aspect of information overload. The third coping strategy—using a less demanding decision model—simultaneously addresses both conditions that produce information overload. Switching from a compensatory to a noncompensatory strategy is an example of shifting to a less demanding decision model because less information is processed. Furthermore, acceleration and filtration are considered small-scale or micro changes to information processing whereas changing the decision model is considered a large-scale or macro change (Maule & Edland, 1997; Maule, Hockey, & Bdzola, 2000). As a result, IS auditors are expected to accelerate and filter first followed by changing their decision model only when necessary.

Acceleration

Acceleration refers to increasing the rate at which information is processed and conceptually is the simplest form of coping with information overload, although it may be the most difficult to sustain over time. Payne, Bettman, and Johnson (1988) found that subjects accelerate their information processing as measured by the average time spent per item of information acquired. Ford, Schmitt, Schechtman, Hults, and Doherty (1989) confirm this finding in their review of process-tracing studies, where they conclude that increases in task complexity (information load) also lead to decreases in mean search time. Accelerated processing has also been noted in group research. Arnold, Sutton, Hayne, and Smith (2000) found that groups who were given a judgment task to perform and told that they would be compensated on the basis of accuracy and decision time chose to accelerate their decision-making approach by decreasing the time spent viewing available information items.

Some studies show that under conditions of high information load and no time constraints, individuals often spend more total time to make decisions as compared with those who have lower information loads (Casey, 1980; Speier, Valacich, &

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Vessey, 1999; Swain & Haka, 2000). Even in the absence of formal time constraints, however, individuals often self-impose time limits on tasks. It is possible, therefore, both to spend more time and to accelerate information processing provided that information load is sufficiently high. Thus, while total time may increase, time per risk factor can decrease if acceleration is used to cope with information overload. Consistent with the prior findings in psychology, we hypothesize that IS auditors who are faced with either condition leading to information overload (i.e., time constraints or high information load) will accelerate information processing. Formally stated,

> *H3: When selecting IS projects for review, information overload leads auditors to accelerate their information processing.*

Coping by accelerating information processing is very cognitively demanding and is likely to be used only if the task is important and if the period of time in which acceleration is to be used is short (Maule & Edland, 1997). These conditions are likely to describe the project-selection task in that it is an extremely important decision having a relatively short information processing time.

Filtration

According to Miller (1960), *filtration* is a commonly adopted coping strategy when decision makers reach their information processing capacity. Filtration consists of attending to the most important information while purposefully ignoring or filtering out the less important information (Ben Zur & Breznitz, 1981; Payne et al., 1988). Increases in information load with corresponding decreases in the proportion of information searched are regarded as evidence that filtration has taken place (Ford et al., 1989).

Filtration is considered beneficial when large amounts of information must be processed and/or time is limited and the information can be classified as more and/or less relevant. In the context of risk assessments for software projects, a multitude of risk factors have been identified as being relevant (Barki et al., 1993; Keil et al., 1998; Schmidt et al., 2001; Wallace & Keil, 2004; Wallace et al., 2004a, 2004b), thus making project risk assessment an information-intensive task. However, research into human information processing suggests that individuals can only process about six or seven chunks of information at one time (Chewning & Harrell, 1990). Hence, the design of both group support system (GSS) and DSS tools often focus on ways to reduce or filter information sets for users in order to avoid information overload (Hiltz & Turoff, 1985; Cook, 1993; Grisé & Gallupe, 2000). Filtering, however, becomes problematic if highly relevant information is ignored, suggesting that this may not be a desirable means of coping with information overload when selecting IS projects for review by an auditor.

While some research in psychology has directly measured filtration by using process tracing, applied studies typically infer filtration by demonstrating a decrease in the proportion of information that is correlated with the decision at higher information loads (Glover, 1997; Spilker & Prawitt, 1997; Burton & Tuttle, 2002) or from survey data (Schultze & Vandenbosch, 1998). The latter inferences are tenuous because filtering is a coping behavior that, without process tracing,

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cannot be distinguished from the inefficient use of information resulting from other coping behaviors. Thus, prior findings in the applied literature provide unclear predictions of whether IS auditors will strategically filter information under conditions of information overload or whether they will simply fail to process information completely. The following hypothesis is therefore based on the literature from psychology and tests whether, under information overload conditions, filtration occurs when selecting IS projects for review.

H4: When selecting IS projects for review, information overload leads auditors to filter information.

Change decision model

One way of simultaneously coping with both the time constraint and information load components of information overload is for the IS auditor to adopt a less cognitively demanding decision model. Prior research has typically investigated the shift from using a compensatory decision model to a noncompensatory model. *Compensatory models* are those that evaluate the attributes of an alternative together rather than separately. A negative value on one attribute may be compensated for by a positive value on another (Edland & Svenson, 1993). In a purely compensatory model, the IS auditor considers all dimensions and performs an exhaustive search of all information. That is, 100% of the information is accessed. This type of information processing can lead to better IS project-review selection decisions because all diagnostic information is attended to and none is ignored. However, compensatory information processing can be extremely cognitively demanding.

Noncompensatory decision models are less cognitively demanding because they do not require examining and considering separate pieces of information together. For example, an IS auditor trying to decide whether to select a particular software project for further review might make this decision based on whether certain risk factors reach a predetermined threshold—the values on remaining risk factors are not considered (i.e., they do not compensate). Because each piece of information can be evaluated separately, noncompensatory strategies require less exhaustive searches of information (Klayman, 1983; Biggs, Bedard, Gaber, & Linsmeier, 1985; Cook, 1993; Cook & Swain, 1993; Swain & Haka, 2000) and are less time demanding. Prior research suggests that high information loads lead to the use of noncompensatory strategies (Cook, 1993; Edland & Svenson, 1993) and simpler strategies (Snowball, 1980). Thus, when IS auditors reach their information-processing capacity due to time constraints or high information load, they are expected to adopt simpler, noncompensatory strategies. Formally stated,

H5: When selecting IS projects for review, information overload leads to use of more noncompensatory strategies.

It is possible to first filter (or ignore) some particular piece of information and then process the remaining subset of information in either a compensatory or noncompensatory manner. When considering the subset of information accessed after controlling for filtering, H5 predicts that information overload leads to a smaller proportion of that subset being accessed by the IS auditor. This is a stronger

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test than in existing applied studies, which look at the proportion of information used in the decision where information usage can be affected by variables other than filtering.

Effects of Information Processing on the Selection Decision

The previous section predicts that IS auditors will adopt specific coping strategies to deal with the stress of information overload. Furthermore, it suggests that there may be an ordered response where acceleration occurs first, followed by filtration, and then by a shift in decision strategy if necessary (Payne et al., 1988; Payne, Bettman, & Luce, 1996). Such an ordered response to information overload suggests that differences in decision outcomes may occur dependent on which coping strategy is adopted. If, in fact, IS auditors do adopt a coping strategy, then it is important to understand the effects on software project risk assessment decision quality.

In general, and without considering the information processing that occurs, information overload results in decrements in decision quality (Chewning & Harrell, 1990; Stocks & Harrell, 1995; Stocks & Tuttle, 1998; Speier et al., 1999; Tuttle & Burton, 1999; Burton & Tuttle, 2002). However, prior research has not considered how the decrements occur with respect to coping strategies. It is important to understand how and if each coping strategy results in suboptimal decisions regarding project selection in order to improve decision making in this area. Prior research in the psychology coping strategy literature often does not examine the quality of decisions in the field or the use of coping strategies by professional subjects performing a job-relevant task.

IS project selection decisions can be measured in terms of decision quality. In practice, software project risk assessments are made on the basis of a continuum of risk factors that could range from low to high risk. Exact measures of risk assessment accuracy are not known until after a project fails or succeeds. Substitute decision quality measures pertinent for the task of monitoring software development project risk may include measures of the ability of the IS auditor to (i) integrate risk factors consistently (*decision consistency*), (ii) use all the available risk factors (*information usage*), (iii) agree with the risk assessments of other IS auditors (*consensus*), and (iv) weigh risk factors appropriately (*variance in information weights*).

Relying on the theory of the hierarchical nature of coping strategies by Payne et al. (1988), this study posits that the necessary coping strategies are adopted by IS auditors in response to information overload and in turn lead to differential effects on project selection decisions as demonstrated by the relevant decision quality measures listed earlier and described in the following sections.

Consistency

Consistency in decision making refers to the decision maker's ability to evaluate the same information consistently and is viewed as a desirable quality in auditing decisions (Dilla & Stone, 1997). Inconsistent decisions to perform an in-depth review of potential runaway software development projects can send the wrong signal to management, thus resulting in suboptimal allocation of resources. Prior research generally indicates that information overload leads to decreases in

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consistency (Chewning & Harrell, 1990; Stocks & Harrell, 1995; Stocks & Tuttle, 1998). We investigate which individual coping strategies contribute to this finding. If acceleration is used, then less time is available to integrate risk factors in a consistent manner. If filtration is used, then consistency may or may not decline depending on whether the auditor consistently ignores the same risk factors across cases. If noncompensatory processing is used, then performance depends on how consistently trade-offs are made on individual risk factors. Thus declines in consistency in relation to each coping strategy are formally hypothesized:

When selecting IS projects for review, auditors who adopt:

H6a: Acceleration will exhibit less consistency in their decisions.

H7a: Filtration will exhibit less consistency in their decisions.

H8a: Noncompensatory processing coping strategies will exhibit less consistency in their decisions.

Cue usage

In the process of deciding which IS projects to select for subsequent in-depth review, the various risk factors become cues to the decision. *Cue usage*, therefore, is a measure of how much information is incorporated into the decision. Ideally, all relevant information should be incorporated into a decision so that the amount of information reflected in the decision is a measure of decision quality. However, information overload research indicates that as information load increases the proportion of relevant information used by decision makers often decreases (Tuttle & Burton, 1999; Burton & Tuttle, 2002). In addition, research regarding cue utilization theory shows that, when under stress, people reduce their cue usage (Choo, 1995). While it is somewhat tautological that filtration should result in lower levels of cue usage (although the conscious choice to ignore certain cues may lead to more consistent use of the remaining cues), it is less clear whether the other two coping strategies are responsible for observed decision quality differences. This leads us to propose the following hypotheses:

When selecting IS projects for review, auditors who adopt:

H6b: Acceleration will use fewer risk factors in their decisions.

H7b: Filtration will use fewer risk factors in their decisions.

H8b: Noncompensatory processing coping strategies will use fewer risk factors in their decisions.

Consensus

Consensus is the degree to which the decisions of different individuals agree with one another. Consensus represents a desirable quality of decisions, because a lack of consensus may suggest arbitrary behavior on the part of the decision maker (Dilla & Steinbart, 2005). Consensus is a commonly used measure of accuracy in audit research because, in many instances, objective criteria are absent in the

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field (Pincus, 1990). Risk assessment is one such task in which consensus has been used to proxy for decision quality (Ashton, 1985). Although prior research indicates that, as information overload increases, consensus decreases (Chewning & Harrell, 1990; Stocks & Harrell, 1995); the effect of specific coping strategies on consensus has yet to be examined. Nevertheless, to the extent that behavioral responses to organizational pressures differ between individuals, one expects that decisions based on coping strategies would differ more across individuals than decisions made without resorting to coping strategies. For instance, it is more likely that thoughtful decisions produce more consensus than do hurried decisions, which are likely to include a larger random component. Likewise, individuals likely differ in which information they choose to filter and in terms of which noncompensatory strategy to adopt when under pressure. Formally stated, we propose that the coping strategies evoked by information overload affect consensus:

When selecting IS projects for review, auditors who adopt:

H6c: Acceleration will exhibit less consensus in their decisions.

H7c: Filtration will exhibit less consensus in their decisions.

H8c: Noncompensatory processing coping strategies will exhibit less consensus in their decisions.

Cue weights

Cue weights describe the relative importance individuals place on a given piece of information in their decisions. Prior research into IT project risk identifies numerous factors that are important to consider when assessing risk, although it is unclear how different project participants view risk (Wallace et al., 2004a). Thus it is also unclear whether and how differences in weighting should occur. Furthermore, as the number of relevant cues increases, differences in relative weights between cues should tend to get smaller and approach an equally weighted model. However, applied research finds just the opposite—that the relative weights on individual pieces of information diverge from an equally weighted model as information overload increases (Burton & Tuttle, 2002).

The statistical variance in the relative cue weights across risk factors measures how closely the IS auditor's model matches a naïve (i.e., equally weighted) decision model. That is, the variance in cue weights is zero when all cues receive the same weight in the decision. The case in which cue weights are most likely to diverge from an equally weighted model (i.e., show greater variance in cue weights) is when the IS auditors adopt noncompensatory processing, because they may, on a case-by-case basis, terminate their decision process before using all of the information. Filtration strategies result in zero weights being placed on filtered cues, but does not dictate the strategy for the remaining risk factors being processed. Hence, it is unclear whether cue weights will vary for the remaining cues with a filtration strategy. One approach to implementing an acceleration strategy is to use uniform cue weights, thus eliminating the cognition involved in trying to differentiate risk

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factors by their importance. Thus the discussion leads to proposing the following hypotheses:

When selecting IS projects for review, auditors who adopt:

H6d: Acceleration will exhibit greater variance in the weights placed on the risk factors in their decisions.

H7d: Filtration will exhibit greater variance in the weights placed on the risk factors in their decisions.

H8d: Noncompensatory processing coping strategies will exhibit greater variance in the weights placed on the risk factors in their decisions.

METHOD

Task and Subjects

To test the hypotheses, an experiment was conducted with IS auditors belonging to the Information Systems Audit and Control Association (ISACA). The task required the IS auditors to indicate their likelihood of selecting various system development projects for in-depth audit review based on a set of risk factors about the status and characteristics of the projects (see Appendix A). IS auditors routinely review IT projects for risk factors similar to those used in the present study (Keil & Mann, 1997; Gelinas & Sutton, 2002). Considering that a company may start projects at various times and that critical junctures occur at different points for each project, selection decisions are most likely made one project at a time and on an individual basis. That is, the IS auditor compares a project's overall risk assessment with the auditor's knowledge of similar projects to determine whether the project exceeds the IS auditor's threshold for risk—in which case it is selected for review. In order to best isolate the effects of how the IS auditor combines risk factors, the task focused on only the risk factors and did not include other extraneous factors that may also impact risk assessments. This design choice removes some of the task realism and, arguably, some of the additional information overload that may occur in the natural environment, thus biasing the study against finding results.

Presumably, the choice of coping strategy that an individual adopts under information overload conditions could be affected by experience with the task. As evidenced by the demographic data shown in Table 1, the subjects were either IS auditors or in closely related occupations. Ninety-four percent had 4-year college degrees or higher. Ninety-two percent had 5 or more years' work experience (74% had more than 10 years of work experience). In general, the participants were professional IS auditors, highly educated, experienced, and otherwise well suited to perform the experimental task.

IS auditors were recruited by sending an e-mail to North American ISACA chapters (67 in all) asking the chapter to invite their members to participate in a voluntary and confidential study. Chapters sent either their own e-mail or forwarded the original e-mail to their members or posted the Web address for the experiment on their chapter Web site or in their newsletter. Inviting participation

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Table 1: Participant demographics.

Education:	
4-Year College Degree	38
Master's Degree	22
Ph.D.	1
Other	4
Number of Years Worked Full Time	
2–4	5
5–10	12
More Than 10	48
Age	
Less Than 25	2
25–40	28
Over 40	35
Gender	
Female	20
Male	45
Field of Employment:	
Government/Education	22
Finance/Banking/Accounting	17
Professional Assurance Consulting	12
Utilities	4
Manufacturing	3
Other	7
Current Professional Activity:	
IS Auditor	34
Internal Auditor	8
IS Consultant	6
Audit Director/General Auditor	4
IS Manager	4
Other	9

by these three different methods (e-mail, link, and newsletter) was necessary to attract qualified professionals but posed a challenge in measuring nonresponse bias. In order to compensate for the inability to measure nonresponse bias, an analysis of early versus late responders was conducted as described later. The invitations to participate resulted in 154 hits on the experiment Web site. Of these hits, 72 completed decision cases for a completion rate of 47%. Of the 72, three were removed for the following reasons: one answered a constant 8 on every case, one was obviously confused and had negative coefficients on every risk factor and negative correlations on the consensus measure, and one did not complete enough cases to analyze. Four auditors completed the experimental task but chose not to provide demographic information.

An analysis of early versus late responders was conducted by splitting the sample into groups and performing analyses of variance (ANOVAs) on all dependent measures. The groupings were tested in three ways: first by splitting the sample in half, next by splitting the sample in thirds, and, finally, by splitting the sample in fourths. The sample split, information load condition, and time pressure

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Figure 2: Experimental design.

	Time Pressure	
Information Load	No	Yes
High - 9 project risk factors	unlimited time	4 1/2 minutes
Low - 6 project risk factors	unlimited time	4 1/2 minutes

conditions (described later) were used as factors, and each dependent measure was tested. There were no significant effects for any dependent measure on the sample split factor; thus, we conclude that there are no differences in the responses of the early versus late responders.

Design

The experiment consisted of a mixed design with two between-subjects factors that were manipulated in a 2 × 2 factorial design (see Figure 2). The first between-subjects variable was information load (low/high). The second between-subjects variable was time pressure (no/yes). Participants were randomly assigned to one of the between-subjects conditions. The within-subjects factor consisted of 16 experimental cases. The cases contained either six or nine risk factors, manipulated each to be high or low in a factorial design (either a 1/4 replication of a 2^6 factorial design [low information load] or a 1/32 replication of a 2^9 factorial design [high information load condition]). As part of the orthogonal design, we selected high/low values to be halfway below 50 (i.e., 25) and halfway above 50 (i.e., 75) and then randomly varied values to be within 15 on either side (i.e., $25 - 15 = 10$ and $25 + 15 = 40$; $75 - 15 = 60$ and $75 + 15 = 90$). This made low and high values symmetrical around high and low midpoints while avoiding extreme values (i.e., near 0 and near 100) and middle values (i.e., near 50/50). The high and low values corresponded to high or low risk. Each instance of the within-subjects design constituted one decision case. Two practice cases preceded the 16 experimental cases for a total of 18 cases. Cases were presented in a single random order for each information load condition.

Information Load Manipulation

The information load manipulation was accomplished by varying the number of risk factors within a case. Following prior research (e.g., Chewning & Harrell, 1990), the high information load group was given nine risk factors per case and the low information load group was given six risk factors, randomly selected from the nine-factor condition. The risk factors are described in Appendix A and are labeled

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as follows: budget, schedule, project size, project scope, management involvement, project structure, user involvement, project technology, and quality of project team. The risk factors used in each case reflect the type of information that IS auditors would typically review in order to determine project risk (Keil & Mann, 1997; Gelinas & Sutton, 2002).

In practice, the IS auditor must evaluate the various risk factors together in order to obtain an overall decision. Each individual dimension may vary on risk (low risk to high risk) and the IS auditor must use their judgment to decide the overall risk threshold. In order to facilitate the experiment, each risk factor was given a risk rating. The risk rating was a randomly generated number between 10 and 40 for low values and between 60 and 90 for high values. As previously mentioned in the design section, the occurrences of the low and high values were manipulated according to the factorial design. Lower values correspond to lower risk, while higher values correspond to higher risk. In both information load conditions, the risk factors appeared in a single random order. Although numerical risk ratings shorten the task for the IS auditor by eliminating the step of accumulating the evidence leading to an assessment for each risk factor, the task still requires the IS auditor to combine the risk factors and to come to the overall risk judgment. Thus, the net effect is to remove a time-consuming step for the IS auditor participants while preserving the essence of the project selection decision.

Time-Pressure Manipulation

The time-pressure manipulation was accomplished by limiting the amount of time that the IS auditors had to complete the 18 cases in one group while allowing the other group unlimited time. The goal behind the time pressure manipulation was to impose time pressure without imposing an unrealistic time constraint. To achieve this objective, pretests were conducted to ensure that the IS auditors had sufficient time to complete the task while at the same time experiencing time pressure. In pretests, the average time per case without time pressure was 15 seconds (4 1/2 minutes for 18 cases). Hence, the auditors in the time pressure condition were told that they had 4 1/2 minutes to complete the study. Pretests were conducted online using auditors from the same population as the subjects.

To reinforce the time-pressure manipulation, the time remaining was communicated to the IS auditors by displaying a clock on the screen that counted down until the time was up. At case number 10, the phrase, "Time Remaining" above the clock turned red to remind IS auditors that time was running out. When the time was up, the IS auditors were not able to access any more information and were required to finalize their decision for the particular case they were working on. The no-time-pressure group was given unlimited time to make their decisions and no countdown clock appeared on the screen in this condition.

Information-Processing Dependent Measures

There are two primary information-processing dependent variables used to measure acceleration, filtration, and the use of noncompensatory strategies. The measures consist of the time spent viewing risk factors and the number of accesses to risk factors. Each was captured during the process-tracing experiment as described

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below. The time spent viewing risk factors reveals the speed with which a subject processed the risk factor and is, therefore, a measure of acceleration and when summed across all risk factors reflects the total time a subject spent with the information. The number of accesses to a specific risk factor reveals whether a subject attended to it. Thus, zero accesses on a specific factor reflect a lack of attentiveness or filtration. Inconsistent access across cases indicates the use of a noncompensatory strategy. For example, if a subject used a noncompensatory strategy, then a less exhaustive search of risk factors is required according to the risk level of the other factors in that case.

Materials

The experimental materials were presented on computer screens via the Internet and consisted of instructions and 18 different cases describing the status of a hypothetical company's software projects. A welcome screen appeared first, followed by a screen of instructions that included the definitions of each risk factor. These definitions remained available to the auditors throughout the experiment. The series of screens that followed contained the risk factors about each of the software projects, one project (i.e., case) per screen. As shown in Appendix A, depressing and holding the mouse button over the risk factor to display the underlying value of the risk factor revealed its risk rating. When the mouse button was released, the risk rating disappeared. The computer tracked the time in milliseconds that the mouse button was depressed along with which risk factor was being viewed and in what order. The first two cases were considered practice and were not used in the analysis. These were followed by the 16 experimental cases as described previously.

A scale was provided at the bottom of each case screen to record the IS auditors' project selection decision. The scale was anchored by the phrases, "definitely do not audit" and "definitely audit." The scale was split in the middle, with 4 to 1 indicating the "not audit" choices and 1 to 4 indicating the "audit" choices. After the cases, there was a screen that requested demographic information followed by a "Thank You" screen at the end. The last screen gave the auditors an e-mail address to request a summary of the results.

Procedure

In order to obtain experienced IS auditors, the experiment was conducted as e-research over the Internet. The program was written in dynamic HTML and Java Script. Custom coding the program in a low-level computer language permitted a substantial amount of control that is not available using template tools such as Flash or Front Page. For example, the computer randomly assigned the auditors to treatment groups, enforced time constraints, and collected precise response times in milliseconds. Precise time measurements were possible because the client-side computer program accessed the internal clock of the auditors' desktop to record viewing times and transmitted the results to the Web server rather than using the server's clock. Hence, time measurements were not affected by variations in data transmission that occur via the Internet when using Web page generators. When the allotted time was up in the time-pressure condition, the program automatically

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stopped displaying information and a message prompted the participants that time was up. Further controls were included to detect exit and reentry into the experiment as well as interruptions. The program was extensively pretested to ensure comparability and consistency across browsers (e.g., MS Explorer and Netscape) and across hardware (e.g., different screen settings). The computer also prevented the IS auditors from indicating a decision without accessing at least one risk factor for that particular case. Also, we expected prior to running the experiment that all participants in a field setting would be under some amount of time pressure. Individual differences on this dimension are controlled by having the computer randomly assign the auditors to treatment conditions. Most important, the computer was able to track the order and elapsed times that the auditors spent viewing each risk factor. This allowed the IS auditors to complete the task at their own location while permitting a high degree of experimenter control via the computer and the ability to trace their information processing.

The instruction page gave general instructions to the auditors and indicated how to begin the cases and described the nature and goal of their task. The instructions advised the auditors that all the information was important and that they should consider all the information before rendering a decision. In addition, the auditors were instructed not to use any form of aid (written or otherwise). After reading the instructions, the auditors were given two practice cases before proceeding to the first experimental case. When the auditors finished all 18 cases, the computer asked them to provide demographic information, including education, age, sex, years of work experience, field of employment, professional activity, and ZIP code. The computer automatically recorded all responses and assigned each participant a globally unique identifier (GUID) number.

DATA ANALYSIS AND RESULTS

All the dependent measures used to test the hypotheses were screened for departures from normality and, when necessary, were transformed to stabilize the variances (Glass & Hopkins, 1996). As previously mentioned, the two practice cases were excluded from all analyses. The following results include only the 16 experimental cases.

Preliminary Analysis

A preliminary analysis was conducted to test the random assignment of the IS auditors to groups. Chi-square tests for differences in education, gender, age, number of years worked, field of employment, and professional activity across treatment groups revealed no significant differences across the four cells of the 2 × 2 experimental design (information load—six or nine risk factors and time pressure—yes or no). The results suggest that the IS auditors were randomly dispersed across treatments. Demographic data were also compared for duplicate responses from the same IS auditor. No two IS auditors had identical ZIP codes or demographics, suggesting that each IS auditor completed the experiment only once.

The time pressure manipulation was checked by comparing the mean time (in seconds) spent on each case for both groups. Note that this included both the

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time accessing the risk factors as well as the time responding to the case. A *t* test revealed that the mean seconds per case (14.04) of the time-pressure group was significantly less ($p < .001$) than the mean seconds per case (29.58) of the no-time-pressure group. The data suggest that the IS auditors in the time-pressure condition felt a need to go faster. The distribution of the time per case in the pressure condition also provided some insight into the success of the manipulation. For the time-pressure condition, participants spent considerably more time on the early cases than on the later cases. On the first experimental case, the mean seconds per case was 21.75, which continually declined by the midpoint (experimental case 8 mean = 11.17) and by the end the mean was 6.84.

Tests of the Research Hypotheses

The following criteria were used in testing the research hypotheses: an alpha level of .05 is considered a significant effect, whereas .10 is considered a marginal effect. All *p* values are two-tailed unless otherwise stated.

The direct effects of information overload on judgment have been studied using policy capturing methodologies (Chewning & Harrell, 1990; Stocks & Harrell, 1995; Stocks & Tuttle, 1998; Tuttle & Burton, 1999). Under this approach, subjects make a series of decisions based on a limited set of information cues (Libby & Lewis, 1982). Their decisions are regressed on the cue values (usually manipulated factorially to be high or low in value) to produce measures of information usage (betas statistically greater than 0), cue importance (relative standardized beta weights), and decision consistency (R^2). Because information overload is theorized to influence these judgment-related measures, policy capturing is helpful in determining the impact of information overload on subsequent decisions.

For the analyses of H1 and H2 standardized beta coefficients were calculated for each subject using a policy-capturing regression model that regresses cue values on responses as follows:

$$\text{Response} = \beta_o + \beta_1(\text{cue}_1) + \cdots + \beta_n(\text{cue}_n) \qquad (1)$$

The response is the IS auditor's judgment of how likely they are to select the project for audit review, and the cues are the actual values of the information items. Larger cue weights (i.e., more important cues) are predicted to correspond with greater viewing time. A separate regression model was estimated for each IS auditor. Seven subjects in the time pressure condition are excluded from this analysis because they ran out of time prior to finishing enough cases to estimate their decision models. Excluding these subjects very likely reduces the power of our tests and works against the hypotheses.

H1 suggests that IS auditors will give greater weight in their decisions to the risk factors that they spent more time viewing. To test H1, correlations between the viewing time for each factor and its standardized beta coefficient were calculated. The mean correlations were significantly greater than zero. The hypothesis predicts that the proportion of significant correlations in the sample will be greater than the .10 alpha level (i.e., more than the number expected by chance). A binomial test was used to test the hypothesis using counts of the individual

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Table 2: Results of hypotheses testing H1 and H2—binomial analysis. Proportion of subjects with significant correlations.[a]

	Mean[b]	Proportion significant at .10	Result of binomial test
Panel A: Standardized Betas with Time Per Risk Factor—H1			
Spearman	.265	19/62 = 31%	$Z = 5.51, p < .01$
Pearson	.253	18/62 = 29%	$Z = 4.99, p < .01$
Panel B: Standardized Betas with Number of Accesses—H2			
Spearman	.198	17/61 = 28%	$Z = 4.69, p < .01$
Pearson	.198	20/61 = 33%	$Z = 5.99, p < .01$

[a]Seven subjects are excluded from this analysis because they ran out of time prior to finishing all 16 cases. One subject had a constant number of accesses.
[b]Mean correlation defined as the correlation between each auditor's six (or nine) relative cue weights and their viewing time on those same cues, averaged across all subjects. All mean correlations are significantly greater than 0 (one-tailed, $p < .02$) using t tests on transformed correlations (Fisher's Z).

significant correlations. If the individual correlation was significant at an alpha level of .10 it was coded as a 1, otherwise a 0. The results for H1 are presented in Table 2, Panel A. Approximately 30% of the subjects have significant correlations between the beta weights for each cue in their decision model and their viewing times for the same cues. A binomial test is significant (Pearson $Z = 4.99$, $p < .01$; Spearman $Z = 5.51, p < .01$), indicating that the number of significant correlations is greater than expected by chance. H1 is supported in that the IS auditors tended to place greater weight on the information they had spent more time viewing.

H2 predicts that risk factors that are repeatedly accessed will be given greater weight in the IS auditors' subsequent project selection decisions. This hypothesis was tested using the same procedure as in H1 except that the beta weights for each risk factor in their decision models was correlated against the total number of accesses during information processing. The factors with the greater number of acquisitions should correspond with the factors having the higher beta weights. Panel B of Table 2 shows that 28%–33% of the IS auditors have significant positive correlations of beta weights and number of accesses. A binomial test is significant (Pearson $Z = 5.99$, $p < .01$; Spearman $Z = 4.69$, $p < .01$), thus indicating the number of significant correlations is greater than chance. The results support H2, suggesting that IS auditors place greater weight on the information they access more when selecting IS projects for review.

H3 predicts that IS auditors under conditions of information overload will accelerate their information processing. In order to test this hypothesis, a 2×2 ANOVA was conducted with time per acquisition (VIEWTIME) as the dependent measure and information load and time pressure as between-subjects factors. VIEWTIME was calculated as the total time spent viewing the project risk factors divided by number of risk factors for their experimental condition (6 or 9). Only the time that the information was displayed (i.e., while the mouse button was depressed) is accumulated here. The time spent moving from one item to another (or thinking without viewing information) is not counted. Thus, VIEWTIME is

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Table 3: Results of hypothesis testing H3—ANOVA.

Panel A: Test for Main Effects of Time Pressure and Information Load—Dependent Measure: Time Per Acquisition (VIEWTIME)					
Source	Sum of Squares	*df*	Mean Square	*F*	Sig.
Model	13.174	3	4.391	13.345	<.001
Error	21.388	65	0.329		
Information Load	1.849	1	1.849	5.620	.021
Time Pressure	9.785	1	9.785	29.736	<.001
Load × Pressure	2.374	1	2.374	7.215	.009

Panel B: Test for Interaction Effect—Means (Raw Variables)			
	Information Load		
Time Pressure	Low—Six Project Risk Factors	High—Nine Project Risk Factors	
	A	B	
No	16.32	17.73	17.03
	$N = 20$	$N = 17$	$N = 37$
	C	D	
Yes	10.03	5.33	7.68
	$N = 17$	$N = 15$	$N = 32$
	13.18	11.53	
	$N = 37$	$N = 32$	

a minimum bound on information processing. The ANOVA results in Table 3, Panel A, show a significant main effect for information load ($F = 5.620, p = .011$, one-tailed) and time pressure ($F = 29.736$, $p < .001$) and a significant interaction ($F = 7.215$, $p = .009$). The interaction (shown in Panel B) shows that, as information load is increased and time pressure is imposed, the IS auditors accelerate their information processing as evidenced in the high information load/time pressure condition (mean VIEWTIME = 5.33). Time pressure has a greater effect under high information load conditions than under low information load conditions (C > D). The combination of information load and time pressure cause the IS auditors to accelerate more than what would be expected by summing their independent effects. Furthermore, the interaction is ordinal, rendering the main effects interpretable.

The main effects indicate that IS auditors in the time-pressure and high-information-load groups spend significantly less time viewing information than the IS auditors in the no-time-pressure group and low-information-load group (means = 7.68 and 11.53 vs 17.03 and 13.18). Similar results are obtained using chi-square analysis. Consistent with expectations, time pressure ($\chi^2 = 9.282$, $p =$ .002) and information load ($\chi^2 = 9.282$ $p = .002$) are significant (in both overload conditions 72% of the auditors had VIEWTIME scores below the median). These findings support H3.

H4 predicts that IS auditors under conditions of information overload will filter project risk factors from their decisions. This suggests that the number of

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Table 4: Results of hypothesis testing H4.[a]

Time Pressure	Information Load: Low—Six Project Risk Factors	High—Nine Project Risk Factors	
No	0% (0/20)	0% (0/17)	0% (0/37)
Yes	5.9% (1/17)	27% (4/15)	16% (5/32)
	2.7% (1/37)	12.5% (4/32)	

[a]Percentage of subjects who filtered one or more project risk factors (number of subjects/cell size).

risk factors not accessed will be greater for subjects in the time-pressure and high-information-load conditions. The dependent measure for H4 is the number of factors not accessed (FILTER). Recall that the computer displayed the time remaining, which turned red on case 10 to remind subjects that time was running out. Few subjects filtered prior to the warning message. Once warned, however, some subjects ignored certain cues from that point. A factor therefore was considered filtered if the IS auditor did not access it after case 9. The FILTER score for each IS auditor consisted of a count of the individual risk factors coded as filtered.

The percentage of IS auditors filtering by condition is presented in Table 4. Except for when both information-load and time-pressure manipulations are imposed together, very little filtering takes place. Without time pressure, no IS auditor filtered. In the time pressure condition, only five IS auditors adopt a filtering strategy. Apparently, IS auditors are very reluctant to completely ignore information that they consider relevant. Because so few IS auditors chose to ignore risk factors, FILTER will not be included as a predictor of decision quality.

H5 predicts that IS auditors under conditions of information overload will tend to employ noncompensatory decision models to simplify their information processing. In order to test this hypothesis, a 2 × 2 ANOVA was conducted with the proportion of project risk factors accessed after filtration (ACCESSED) as the dependent measure and information load and time pressure as between-subjects factors. ACCESSED was calculated as the number of risk factors accessed after subtracting the filtered factors and dividing by the total number of remaining risk factors available. Noncompensatory processing is conceptually different from acceleration and filtration, because, unlike acceleration and filtration, the decision to access a specific risk factor is based on the values of other factors in each individual case. As a result, a noncompensatory process results in risk factors that are neither consistently ignored or consistently selected, thus setting this strategy apart from filtration. However filtration may occur simultaneously with noncompensatory processing so that the effects of filtration must be isolated before examining noncompensatory processing effects. For example, a decision maker may reduce cognitive load first by filtering or completely ignoring some risk factors and then by concentrating on the remaining subset of factors. The remaining subset can either be processed in a compensatory or noncompensatory manner. If auditors use a pure compensatory strategy on the subset of information then they will employ an exhaustive search by accessing 100% of the subset of information because high

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Table 5: Results of hypothesis testing H5—ANOVA.

Panel A: Test for Main Effects of Time Pressure and Information Load—Dependent Measure: Proportion of Project Risk Factors Accessed after Filtration (ACCESSED)

Source	Sum of Squares	*df*	Mean Square	*F*	Sig.
Model	5.658	3	1.886	14.022	<.001
Error	8.348	65	0.128		
Information Load	1.449	1	1.449	11.286	.001
Time Pressure	3.028	1	3.028	23.579	<.001
Load × Pressure	1.646	1	1.646	12.813	.001

Panel B: Test for Interaction Effect—Means (Raw Variables)

Time Pressure	Information Load: Low—Six Project Risk Factors	Information Load: High—Nine Project Risk Factors	
No	A .98 $N = 20$	B .98 $N = 17$	.98 $N = 37$
Yes	C .95 $N = 17$	D .77 $N = 15$	.86 $N = 32$
	.97 $N = 37$	.88 $N = 32$	

risk on some factors can be compensated for by low risk on other factors. Thus, a subject that sees 9 risk factors and has filtered 2 will access 112 information items over the 16 cases ($7 \times 16 = 112$) and the proportion of information accessed after filtration (ACCESSED) will be 100% (112/112). However, if auditors use a noncompensatory strategy, then they are less likely to use an exhaustive search because certain risk factors reaching a predetermined threshold by an individual auditor will not be compensated for by low risk on other factors; thus those remaining factors will not be selected for that case, resulting in fewer than 100% of the information being accessed (i.e., less than 112). Therefore, the ACCESSED for the noncompensatory strategy users will be less than 100%.

The ANOVA results in Table 5, Panel A, show a significant main effect of information load ($F = 11.286, p = .001$) and time pressure ($F = 23.579, p < .001$) and a significant interaction effect ($F = 12.813, p = .001$) (shown in Panel B). As information load increases and time pressure is imposed, the IS auditors tend to use a smaller portion of information (i.e., more noncompensatory processing) as evidenced by the high-information-load/time-pressure cell (mean ACCESSED = .77). Time pressure has a greater effect under high information load conditions than under low information load conditions (cell C > D). The interactive effect of the information items and time pressure is consistent with our theory that information overload is a joint function of the amount of information and the time available to process it. The main effects indicate that IS auditors in the high-information-load (mean = .88) and time-pressure (mean = .86) groups use a smaller proportion of

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information than the IS auditors in the low-information-load (mean = .97) and no-time-pressure (mean = .98) groups. These findings support H5.

The remaining analyses are organized by dependent measure and pertain to H6 and H8 only. H7 was omitted from the analysis because the IS auditors did not use a filtering strategy, which is necessary to examine H7.

H6a and H8a predict that consistency will decline with the use of accelerated or noncompensatory processing. The dependent measure for the 2 × 2 ANOVA analysis of H6a and H8a was the adjusted R^2 from the policy-capturing model obtained by regressing the project-selection responses across the 16 cases onto the project risk values for each case. A separate regression was computed for every IS auditor. The independent variables were derived by splitting VIEWTIME and ACCESSED at the median (referred to as MEDIAN VIEWTIME [below and above] and MEDIAN ACCESSED [below and above]). IS auditors in the below-median VIEWTIME cell spent less time processing information and are therefore predicted to have lower adjusted R^2 values. Likewise, IS auditors in the below-median ACCESSED cell used noncompensatory processing and are therefore predicted to have lower adjusted R^2 values. The ANOVA results in Table 6, Panel A, show a significant effect of VIEWTIME ($F = 6.498$, $p = .007$, one-tailed). The mean adjusted R^2 for the below-median VIEWTIME group is .437 ($N = 29$) as compared with the above-median VIEWTIME group of .594 ($N = 33$). The IS auditors

Table 6: Results of hypotheses testing H6a and H8a—ANOVA.

Panel A: ANOVA Results—Dependent Measure: Adjusted R^2

Source	Sum of Squares	*df*	Mean Square	*F*	Sig.
Model	.544	3	.181	2.636	.058
Error	3.992	58	.06882		
MEDIAN VIEWTIME	.447	1	.447	6.498	.013
MEDIAN ACCESSED	.03396	1	.03396	.493	.485
ACCESSED × VIEWTIME	.125	1	.125	1.821	.182

Panel B: Mean Adjusted R^2

	VIEWTIME – H6a		
ACCESSED – H8a	Below Median	Above Median	
Below Median	A .417 $N = 16$	B .683 $N = 12$	.531 $N = 28$
Above Median	C .461 $N = 13$	D .543 $N = 21$	.512 $N = 34$
	.437 $N = 29$	.594 $N = 33$	

MEDIAN VIEWTIME = median split of time per acquisition into two groups (above, below); the below group represents those subjects who accelerated.
MEDIAN ACCESSED = median split of proportion of risk factors accessed after filtration into two groups (above, below); the below group represents those subjects who used noncompensatory processing.
Type III Sum of Squares are reported for factor effects.

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who spent less time processing the project risk factors are less consistent, providing support for H6a. No differences in adjusted R^2 are associated with MEDIAN ACCESSED (i.e., noncompensatory processing), thus H8a is not supported and the interaction of MEDIAN VIEWTIME and MEDIAN ACCESSED is not significant.

H6b and H8b predict that IS auditors will use fewer project risk factors in their decisions as a result of using information processing coping strategies. The dependent measure for the 2 × 2 ANOVA analysis of the hypotheses was cue usage. Cue usage was calculated as the count of significant coefficients from a stepwise regression model for each subject and was scaled by the number of available cues. (The results of the stepwise selection method were very similar to those of the full model in terms of R^2 values and coefficient significance. Also, forward and backward selection methods produce similar results. The stepwise method was used because it maximizes the ability to detect significant betas with a small sample size. In addition, an alpha level of .10 was used for significant beta coefficients). The independent variables were MEDIAN VIEWTIME (below and above) and MEDIAN ACCESSED (below and above). The IS auditors in the below-median information-processing conditions were predicted to use a smaller proportion of cues (i.e., risk factors) in their subsequent decisions. The ANOVA results in Table 7, Panel A, show a significant effect of VIEWTIME ($F = 2.897$, $p = .047$, one-tailed) and an interaction effect of VIEWTIME and ACCESSED ($F = 7.359$, $p = .009$) and no significant main effect for MEDIAN ACCESSED.

As can be seen in Table 7, Panel B, an examination of the interaction effect reveals that IS auditors who were both above the median in VIEWTIME and below the median in ACCESSED, use the most information in their decision (cell B, mean = .570). This indicates that IS auditors who adopt noncompensatory processing but spend more time processing the information maintain a high level of cue usage. Only when the IS auditors both spend less time and adopt noncompensatory processing does this reduce the amount of information reflected in their decisions (cell A, mean = .292). The main effect of VIEWTIME reveals that IS auditors who spent less time processing information use fewer cues (mean = .370) as compared to IS auditors who spent more time (mean = .463). In summary, the results provide support for H6b—auditors who accelerate their information processing use a smaller proportion of risk factors in their project selection decisions. Support for H8b is qualified in that noncompensatory processing only affects the number of risk factors used when IS auditors also speed up their information processing.

H6c and H8c predict that an auditor's consensus with the decisions of other auditors about which projects to select will decline as a result of acceleration and noncompensatory coping strategies. Consensus, or the degree of agreement between IS auditors, is a commonly used surrogate for decision quality in audit research (Pincus, 1990). Consensus was calculated as the mean pairwise correlation for each IS auditor's decisions with the decisions of the other participants in the same treatment group. Higher correlations indicate higher consensus.

The factors in the 2 × 2 ANOVA analysis were MEDIAN VIEWTIME (below and above) and MEDIAN ACCESSED (below and above). The hypotheses predict that the lowest consensus will occur for the groups of IS auditors who are

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Table 7: Results of hypotheses testing H6b and H8b—ANOVA.

Panel A: ANOVA Results—Dependent Measure: Proportion of Risk Factors Used

Source	Sum of Squares	*df*	Mean Square	*F*	Sig.
Model	.556	3	.189	3.218	.029
Error	3.403	58	.05867		
MEDIAN VIEWTIME	.170	1	.170	2.897	.094
MEDIAN ACCESSED	.0001608	1	.0001608	.003	.958
VIEWTIME × ACCESSED	.432	1	.432	7.359	.009

Panel B: Mean Proportion of Project Risk Factors Used and Interaction Comparisons

	VIEWTIME—H6b		
ACCESSED—H8b	Below Median	Above Median	
Below Median	A .292 $N = 16$	B .570 $N = 12$	.412 $N = 28$
Above Median	C .466 $N = 13$	D .402 $N = 21$	.426 $N = 34$
	.370 $N = 29$	.463 $N = 33$	

MEDIAN VIEWTIME = median split of time per acquisition into two groups (above, below); the below group represents those subjects who accelerated.
MEDIAN ACCESSED = median split of proportion of cues accessed after filtration into two groups (above, below); the below group represents those subjects who used noncompensatory processing.
Type III Sum of Squares are reported for independent variable effects.
Significant differences in means: A vs. B $p = .002$.
Marginal differences in means: A vs. C $p = .075$; B vs. D $p = .056$.

below the medians. The ANOVA results in Table 8, Panel A, show a significant effect of VIEWTIME ($F = 10.087, p = .001$, one-tailed) and an interaction effect of VIEWTIME and ACCESSED ($F = 5.166$, $p = .026$). An examination of the interaction effect in Panel B reveals that, as expected, those who both accelerated and used noncompensatory processing (cell A) had the lowest consensus (mean = .329) but, contrary to expectations, those who spent more time but used noncompensatory processing (cell B) had the highest consensus (mean = .540). One possible explanation for this is that IS auditors reached greater consensus by first uniformly simplifying their information processing and then spending more time on the task. The main effect of VIEWTIME shows that IS auditors who spent less time processing information (below median VIEWTIME, cells A and C) demonstrate a lower degree of consensus (mean = .360) compared to IS auditors who spent more time processing information (above median VIEWTIME, cells B and D, mean = .479).

H6d and H8d predict that, when IS auditors employ coping strategies as a result of information overload, they will increase the weight they place on the risk factors that they consider more important, while deemphasizing project risk factors that they believe are of lesser importance. This is predicted to lead to greater variance in weights across risk factors in the IS auditors' decision models. The standard deviation (square root of the variance) in beta coefficients for each

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Table 8: Results of hypotheses testing H6c and H8c—ANOVA.

Panel A: ANOVA Results—Dependent Measure: Consensus					
Source	Sum of Squares	*df*	Mean Square	*F*	Sig.
Model	.528	3	.176	4.882	.004
Error	2.342	65	.03604		
MEDIAN VIEWTIME	.363	1	.363	10.087	.002
MEDIAN ACCESSED	.002753	1	.002753	.076	.783
VIEWTIME × ACCESSED	.186	1	.186	5.166	.026

Panel B: Mean Consensus and Interaction Comparisons			
	VIEWTIME—H6c		
ACCESSED—H8c	Below Median	Above Median	
Below Median	A .329 $N = 21$	B .540 $N = 12$	.406 $N = 33$
Above Median	C .404 $N = 15$	D .444 $N = 21$	.427 $N = 36$
	.360 $N = 36$	.479 $N = 33$	

MEDIAN VIEWTIME = median split of time per acquisition into two groups (above, below); the below group represents those subjects who accelerated.
MEDIAN ACCESSED = median split of proportion of risk factors accessed after filtration into two groups (above, below); the below group represents those subjects who used noncompensatory processing.
Type III Sum of Squares are reported for independent variable effects.
Significant differences in means: A vs. B $p < .001$; A vs. D $p = .026$; B vs. C $p = .026$; B vs. D $p = .043$.

risk factor was used as the dependent measure in the 2 × 2 ANOVA analysis. The independent variables were MEDIAN VIEWTIME (below and above) and MEDIAN ACCESSED (below and above). The hypotheses predict that the largest variance will be in the below-median conditions. The ANOVA results in Table 9, Panel A, show a marginally significant effect of ACCESSED ($F = 2.710, p = .053$, one-tailed). Panel B shows IS auditors in the below-median ACCESSED cells have the largest variance (mean = .0442) compared to IS auditors whose ACCESSED is above the median (mean = .0367). When the IS auditors use noncompensatory processing, they tend to differentially weight the project risk factors more so than when their information acquisition is consistent with compensatory processing. The results provide limited support for H8d. No support is obtained for H6d in that neither the main effect of VIEWTIME is significant ($p = .279$) nor the interaction ($p = .349$).

DISCUSSION

This study examines the information processing and quality of decision making involved in the review of software development projects when information overload conditions exist in the environment. Several findings have important implications

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Table 9: Results of hypotheses testing H6d and H8d—ANOVA.

Panel A: ANOVA Results—Dependent Measure: Standard Deviation in Beta Coefficients

Source	Sum of Squares	*df*	Mean Square	*F*	Sig.
Model	.01382	3	.004605	1.429	.244
Error	.187	58	.003223		
MEDIAN VIEWTIME	.003850	1	.003850	1.194	.279
MEDIAN ACCESSED	.008736	1	.008736	2.710	.105
VIEWTIME × ACCESSED	.002877	1	.002877	.893	.349

Panel B: Mean Variance in Standardized Beta Coefficients

	VIEWTIME—H6d		
ACCESSED—H8d	Below Median	Above Median	
Below Median	A .0435 $N = 16$	B .0451 $N = 12$	.0442 $N = 28$
Above Median	C .0291 $N = 13$	D .0414 $N = 21$	.0367 $N = 34$
	.0370 $N = 29$	.0427 $N = 33$	

MEDIAN VIEWTIME = median split of time per acquisition into two groups (above, below); the below group represents those subjects who accelerated.
MEDIAN ACCESSED = median split of proportion of risk factors accessed after filtration into two groups (above, below); the below group represents those subjects who used noncompensatory processing.
Type III Sum of Squares are reported for independent factor effects.

for managerial decision making given that managers rely on in-depth reviews of at-risk projects to make decisions regarding resource allocations. Managers can use the evidence provided to more effectively manage the process of identifying risky projects. This research provides evidence about the information-processing difficulties that lead to lower-quality decisions and ties prior research on coping strategies to specific effects on decision quality.

Our findings suggest that viewing time and number of accesses to software project risk factors are positively associated with a tendency of decision makers to place more weight on that risk factor in their subsequent decisions. Nearly a third of the participants had significant correlations between the time they spent viewing the risk factors and the weight they subsequently placed on that risk factor in their software development project selection decisions. They also tended to place more weight on risk factors that they had accessed more often.

The results clearly show that decision makers cope with information overload by accelerating their information processing and by adopting noncompensatory processing. No substantial evidence of filtration was found and only a very few participants adopted filtration. One possibility is that the participants took very seriously our instruction to "use all the information" although we do observe that any such reluctance to ignore information cues during their information search

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did not prevent them from ignoring cues in their decisions. The results suggest that decision makers in an IT governance context will speed up their cognitive processing, use as much information as possible, and employ noncompensatory strategies in order to cope with information overload. These findings are consistent with prior research in psychology in regard to acceleration and choice of strategy. They diverge with respect to filtration. This is likely due to our use of experienced, professional subjects who were unwilling to filter important information that they considered relevant despite time and information-load pressures. The finding is also consistent with the idea that auditors may perceive a truncated sample as less tolerable than other alternatives when time pressure is an issue (Coram, Ng, & Woodliff, 2004).

As a result of employing coping strategies, we observed related differences in decision quality. When our participants accelerated their information processing, their decision consistency, amount of information used in their decision, and consensus among one another declined. Furthermore, as the participants coped with information overload by adopting noncompensatory processing, this affected the weighting of the project risk factors in their subsequent selection decisions. The results indicate that decision makers will emphasize certain risk factors and deemphasize other risk factors as a result of coping with information overload. These results are consistent with Tuttle and Burton (1999), who observed overemphasis on more important cues and underemphasis on less important cues in the presence of information-overload conditions for participants in a laboratory market study. This finding has both good and bad implications. Changing the emphasis (or weight) on the IS project risk factors may produce higher-quality decisions than filtering out information completely. However, this strategy is still a departure from the "best" decision model because some risk factors are improperly weighted. No evidence was found to suggest any systematic differences between particular risk factors. Thus the results are due to differences in strategies and not differences in risk factors.

When the participants coped with information overload by adopting both accelerated processing and by using noncompensatory decision models, the result was further decrements in the proportion of risk factors used and in consensus across auditors about which projects should be selected. However, when noncompensatory processing was used without acceleration, the participants performed better. This finding suggests that acceleration leads to poorer performance that accentuates the negative effects of using a noncompensatory decision model but that noncompensatory processing by itself does not necessarily affect performance. Nonetheless, the results suggest that the ability of management to effectively manage at-risk projects depends on how the decision maker reacts to factors somewhat under organizational control, such as information overload and coping strategy. This research suggests that managers can help alleviate the problems due to coping strategies by focusing resources on the development of decision aids designed to reduce accelerated information processing.

Overall the findings of this research support the conceptual model shown in Figure 1. Time pressure and high information loads resulted in information overload. In order to cope with information overload, IS auditors employed the coping strategies of accelerated and noncompensatory processing. These strategies

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affected their decisions differently in that using acceleration reduced consistency, amount of information used, and consensus, but not the weighting of software project risk factors. Using noncompensatory processing affected the weighting of software project risk factors but did not affect consistency and only affected the amount of information used and consensus when acceleration was also employed. In sum, the use of coping strategies reduced decision quality. Managers should benefit from knowing that this IT governance-monitoring activity could be adversely affected in practice when information overload conditions exist and consider allocating resources to correct the organizational and environmental pressures.

CONCLUSIONS

This study has important implications for research and theory. Research concerning software project oversight has considered many facets of project risk ranging from the types of risks to perceptions of project managers but has not to our knowledge considered the monitoring function performed by IS auditors. Information processing and the decisions associated with the monitoring function of IS auditors is an important component of IT governance. Prior research on information processing has relied on a model of decision making that has not explicitly related information-processing behavior together with specific coping strategy to their effects on decision quality. Thus this study extends the research from psychology by examining the link between individual adaptive strategies (Payne et al., 1993, 1995; Maule et al., 2000) and their specific effects on decisions and by providing evidence of the link between the time spent viewing information and judgment (Wedell & Senter, 1997). By combining two separate methodologies, policy capturing and process tracing, this study obtained an understanding of how information overload affects both the IS auditors' information processing and their software project selection decision models. It also permitted an examination of how the two methods (and thus information processing and judgment) relate to each other.

This study also has important practical implications. Runaway IS development projects are a significant IT governance issue. Management involvement in the development process is a key factor in project success (Keil & Mann, 1997; Keil et al., 1998; Wallace et al., 2004a). Management needs objective reviews of software projects to be informed if a project is in trouble. Recent research reports that the deficiencies in developing and maintaining systems may have serious consequences concerning the Sarbanes-Oxley Act (Armour, 2005). Thus IS auditors are likely to spend more time monitoring such projects as firms comply with the requirements of the Act. Yet IS audit recruiting firms have been unable to fully staff IS audit positions owing to a growing shortage of candidates for some time (Tuck, 2000), and the trend is continuing for this high-demand specialty (Expansion Management, 2005). At the same time, the nature of IS audit services is rapidly expanding into areas such as real-time assurance, continuous auditing, security, privacy, electronic commerce, and business continuity assurance (Bagranoff & Vendrzyk, 2000). This suggests that IS auditors operate under severe time constraints and a growing possibility of information overload. Furthermore, IS auditors will likely continue to face information overload conditions in the future because of the growing complexity of technology and the dynamic nature of the organizational contexts in which

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technology is employed. The results of this study provide some evidence to help management better understand how to respond to different situations that might lead to information overload for their IS auditors. For example, designing a DSS or decision aids that assist IS auditors with information processing in the tasks where information overload conditions exist would help IS auditors overcome the tendency to use coping strategies such as accelerated or noncompensatory processing. By understanding these effects, management can be in a better position to develop ways to mitigate the negative performance effects on decisions.

This study is subject to the typical limitations of experimental research as well as limitations in experimenter control that are inherent in research conducted over the Internet. Therefore, caution should be used when generalizing these results to other groups and tasks. For example, our task was designed to study specific information-processing attributes and not evidence evaluation per se and was constrained by the availability of our experienced IS auditors. Hence, we removed the evidence evaluation aspects of the task by preassigning risk ratings to individual software project risk factors. Had we added the complexity of rating individual risk factors before making the overall risk rating for the project, we believe we may have found even stronger evidence of information overload. Furthermore, because the data were collected via the Internet by contacting ISACA chapters rather than by contacting individual auditors directly, it is difficult to ascertain response rate metrics. In lieu of nonresponse bias testing, an analysis of early versus late responders was conducted and no differences were found. Nonetheless, it is unclear whether our particular sample affected the results. We believe, however, that this is unlikely to be an issue in our study because of its focus on elementary information processing, which should be relatively invariant to subject selection biases. We also note that we did not provide economic incentives to the participants and rely on the fact that the study was voluntary and that the auditors are experienced professionals to motivate attention.

Future research should consider IS designs that may help reduce the effects of the coping behaviors demonstrated in this study. Carefully designed decision support tools that compensate for the effects of acceleration and noncompensatory processing may be useful. Future research should seek to understand all the tasks and behaviors associated with IS development risk pertaining to the management of risk, the monitoring of risk, and resource allocation decisions by management. [Received: March 2006. Accepted: June 2007.]

REFERENCES

Armour, P. G. (2005). Sarbanes-Oxley and software projects. *Communications of the ACM, 48*(6), 15–17.

Arnold, V., Sutton, S. G., Hayne, S. C., & Smith, C. A. P. (2000). Group decision making: The impact of opportunity cost time pressure and group support systems. *Behavioral Research in Accounting, 12*, 69–96.

Ashton, A. H. (1985). Does consensus imply accuracy in accounting studies of decision making? *The Accounting Review, 60*, 173–185.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Bagranoff, N. A., & Vendrzyk, V. P. (2000). The changing role of IS audit among the big five US-based accounting firms. *Information Systems Control Journal, 5*, 33–37.

Barki, H., Rivard, S., & Talbot, J. (1993). Toward an assessment of software development risk. *Journal of Management Information Systems, 10*, 203–225.

Ben Zur, H., & Breznitz, S. J. (1981). The effect of time pressure on risky choice behavior. *Acta Psychologica, 47*(2), 89–104.

Berghel, H. (2005). The two sides of ROI: Return on investment vs. risk of incarceration. *Communications of the ACM, 48*(4), 15–20.

Biggs, S. F., Bedard, J. C., Gaber, B. G., & Linsmeier, T. J. (1985). The effects of task size and similarity on the decision behavior of bank loan officers. *Management Science, 31*, 970–987.

Brown, W., & Nasuti, F. (2005). Sarbanes-Oxley and enterprise security: IT governance—What it takes to get the job done. *Security Management Practices, 14*(5), 15–28.

Burton, G. F., & Tuttle, B. (2002). Market behavior under information overload conditions: Evidence from the laboratory. Working paper, University of Nebraska, Lincoln, Nebraska.

Casey, C. J. (1980). Variation in accounting information load: The effect on loan officers' prediction of bankruptcy. *The Accounting Review, 55*(1), 36–48.

Chewning, G., & Harrell, A. (1990). The effect of information load on decision makers' cue utilization levels and decision quality in a financial distress decision task. *Accounting, Organizations and Society, 15*, 527–542.

Choo, F. (1995). Auditors' judgment performance under stress: A test of the predicted relationship by three theoretical models. *Journal of Accounting, Auditing and Finance, 10*, 611–641.

Cook, G. (1993). An empirical investigation of information search strategies with implications for decision support system design. *Decision Sciences, 24*, 683–697.

Cook, G., & Swain, M. R. (1993). A computerized approach to decision process tracing for decision support system design. *Decision Sciences, 24*, 931–952.

Cooksey, R. W. (1996). *Judgment analysis theory, methods, and applications*. San Diego, CA: Academic Press.

Coram, P., Ng, J., & Woodliff, D. R. (2004). The effect of risk of misstatement on the propensity to commit reduced audit quality acts under time budget pressure. *Auditing: A Journal of Practice and Theory, 23*, 159–167.

Dilla, W. N., & Steinbart, P. J. (2005). The effects of alternative supplementary display formats on balanced scorecard judgments. *International Journal of Accounting Information Systems, 6*, 159–176.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Dilla, W. N., & Stone, D. N. (1997). Representations as decision aids: The asymmetric effects of works and numbers on auditors' inherent risk judgments. *Decision Sciences, 28*, 709–743.

Duffy, S. A., & Rayner, K. (1990). Eye movements and anaphor resolutions: Effects of antecedent typicality and distance. *Language and Speech, 33*(2), 103–119.

Edland, A., & Svenson, O. (1993). Judgment and decision making under time pressure: Studies and findings. In O. Svenson & A. J. Maule (Eds.), *Time pressure and stress in human judgment and decision making*. New York: Plenum, 27–39.

Eppler, M. J., & Mengis, J. (2004). The concept of information overload: A review of literature from organization science, accounting, marketing, MIS, and related disciplines. *The Information Society, 20*, 325–344.

Expansion Management. (2005). Starting salaries for IT workers to rise. *Expansion Management Short Takes*, December 2.

Field, J. M., Ritzman, L. P., Safizadeh, M. H., & Downing, C. E. (2006). Uncertainty reduction approaches, uncertainty coping approaches, and process performance in financial services. *Decision Sciences, 37*, 149–175.

Ford, J. K., Schmitt, N., Schectman, S. L., Hults, B. M., & Doherty, M. L. (1989). Process tracing methods: Contributions, problems, and neglected research questions. *Organizational Behavior and Human Decision Processes, 43*(1), 75–117.

Gelinas, U. J., & Sutton, S. G. (2002). *Accounting information systems* (5th ed.). Cincinnati, OH: South-Western.

Glass, G. V., & Hopkins, K. D. (1996). *Statistical methods in education and psychology* (3rd ed.). Needham Heights, MA: Allyn and Bacon.

Glover, S. M. (1997). The influence of time pressure and accountability on auditors' processing of nondiagnostic information. *Journal of Accounting Research, 35*, 213–224.

Grisé, M., & Gallupe, B. (2000). Information overload: Addressing the productivity paradox in face-to-face electronic meetings. *Journal of Management Information Systems, 16*, 157–185.

Hegarty, M. (1992). The mechanics of comprehension and the comprehension of mechanics. In K. Rayner (Ed.), *Eye movements and visual cognition: Scene perception and reading*. New York: Springer-Verlag, 428–443.

Hettigei, N. T. (2005). The auditor's role in IT development projects. *Information Systems Control Journal, 4*, 44.

Hiltz, S. R., & Turoff, M. (1985). Structuring computer-mediated communication systems to avoid information overload. *Communications of the ACM, 28*, 680–689.

ITGI. (2007). IT control objectives for Basel II: The importance of governance and risk management for compliance exposure draft. IT Governance Institute, accessed May 21, 2007, available at http://www.itgi.org.

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Jones, Q., Ravid, G., & Rafaeli, S. (2004). Information overload and the message dynamics of online interaction spaces: A theoretical model and empirical exploration. *Information Systems Research, 15*, 194–210.

Keil, M., Cule, P., Lyytinen, K., & Schmidt, R. (1998). A framework for identifying software project risks. *Communications of the ACM, 41*(11), 76–83.

Keil, M., & Mann, J. (1997). The nature and extent of IT project escalation: Results from a survey of IS audit and control professionals. *IS Audit and Control Journal, 2*, 66–69.

Keil, M., Mann, J., & Rai, A. (2000). Why software projects escalate: An empirical analysis and test of four theoretical models. *MIS Quarterly, 24*, 631–664.

Keil, M., Rai, A., Mann, J. E. C., & Zhang, G. P. (2003). Why software projects escalate: The importance of project management constructs. *IEEE Transactions on Engineering Management, 50*, 251–261.

Klayman, J. (1983). Analysis of predecisional information search patterns. In *Analyzing and aiding decision processes*. Budapest, Hungary: Publishing House of the Hungarian Academy of Sciences.

Libby, R., & Lewis, B. L. (1982). Human information processing in accounting: The state of the art in 1982. *Accounting, Organizations and Society, 7*, 231–280.

Lusk, C. M. (1993). Assessing components of judgments in a operational setting. In O. Svenson & A. J. Maule (Eds.), *Time pressure and stress in human judgment and decision making*. New York: Plenum, 309–322.

Maule, A. J., & Hockey, G. R. J. (1993). State, stress and time pressure. In O. Svenson & A. J. Maule (Eds.), *Time pressure and stress in human judgment and decision making*. New York: Plenum, 83–102.

Maule, A. J., & Edland, A. C. (1997). The effects of time pressure on human judgment and decision making. In R. Raynard, W. R. Crozier, & O. Svenson (Eds.), *Decision making cognitive models and explanations*. New York: Routledge, 189–204.

Maule, A. J., Hockey, G. R. J., & Bdzola, L. (2000). Effects of time pressure on decision making under uncertainty: Changes in the affective state of information processing strategy. *Acta Psychologica, 104*, 283–301.

Miller, J. G. (1960). Information input overload and psychopathology. *American Journal of Psychiatry, 116*(Feb), 695–704.

Payne, J. W., Bettman, J. R., & Luce, M. F. (1996). When time is money: Decision behavior under opportunity-cost time pressure. *Organizational Behavior and Human Decision Processes, 66*, 131–152.

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1988). Adaptive strategy selection in decision making. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14*, 534–552.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). *The adaptive decision maker.* Cambridge, UK: Cambridge University Press.

Payne, J. W., Bettman, J. R., Johnson, E. J., & Luce, M.F. (1995). An information processing perspective on choice. In J. Busemeyer, R. Hastie, & D. L. Medlin (Eds.), *Decision making from a cognitive perspective.* New York: Academic Press, 137–175.

Pincus, K. V. (1990). Audit judgment consensus: A model for dichotomous decisions. *Auditing: A Journal of Practice and Theory, 9*(2), 1–20.

Rayner, K., & Morris, R. K. (1990). Do eye movements reflect higher order processes in reading? In R. Groner, G. d'Ydewalle, & R. Parhan (Eds.), *From eye to mind: Information acquisition in perception, search and reading*. Amsterdam: North-Holland, 179–190.

Schick, G., Gordon, L., & Haka, S. (1990). Information overload: A temporal approach. *Accounting, Organizations and Society, 15*(3), 199–220.

Schmidt, R., Lyytinen, K., Keil, M., & Cule, P. (2001). Identifying software project risks: An international Delphi study. *Journal of Management Information Systems, 17*(4), 5–36.

Schultze, U., & Vandenbosch, B. (1998). Information overload in a groupware environment: Now you see it, now you don't. *Journal of Organizational Computing and Electronic Commerce, 8*(2), 127–148.

Speier, C., Valacich, J. S., & Vessey, I. (1999). The influence of task interruption on individual decision making: An information overload perspective. *Decision Sciences, 30*, 337–360.

Spilker, B. C., & Prawitt, D. F. (1997). Adaptive responses to time pressure: The effects of experience on tax information search behavior. *Behavioral Research in Accounting, 9*, 172–198.

Stocks, M., & Harrell, A. (1995). The impact of an increase in accounting information level on the judgment quality of individuals and groups. *Accounting, Organizations and Society, 20*, 685–700.

Stocks, M., & Tuttle, B. (1998). An examination if the information presentation effects on financial distress predictions. *Advances in Accounting Information Systems, 6*, 107–128.

Snowball, D. (1980). Some effects of accounting expertise and information load: An empirical study. *Accounting Organizations and Society, 5*, 323–338.

Swain, M. R., & Haka, S. F. (2000). Effects of information load on capital budgeting decisions. *Behavioral Research in Accounting, 12*, 171–198.

Tuck, R. (2000). Report from the year 2000: IS audit recruitment. *Information Systems Control Journal, 5*, 13.

Tuttle, B., & Burton, F. G. (1999). The effects of a modest incentive on information overload in an investment analysis task. *Accounting Organizations and Society, 24*, 673–687.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

Wallace, L., & Keil, M. (2004). Software project risk and their effect on outcomes. *Communications of the ACM, 47*(4), 68–73.

Wallace, L., Keil, M., & Rai, A. (2004a). How software project risk affects project performance: An investigation of the dimensions of risk and an exploratory model. *Decision Sciences, 35*, 289–321.

Wallace, L., Keil, M., & Rai, A. (2004b). Understanding software project risk: A cluster analysis. *Information and Management, 42*(1), 115–125.

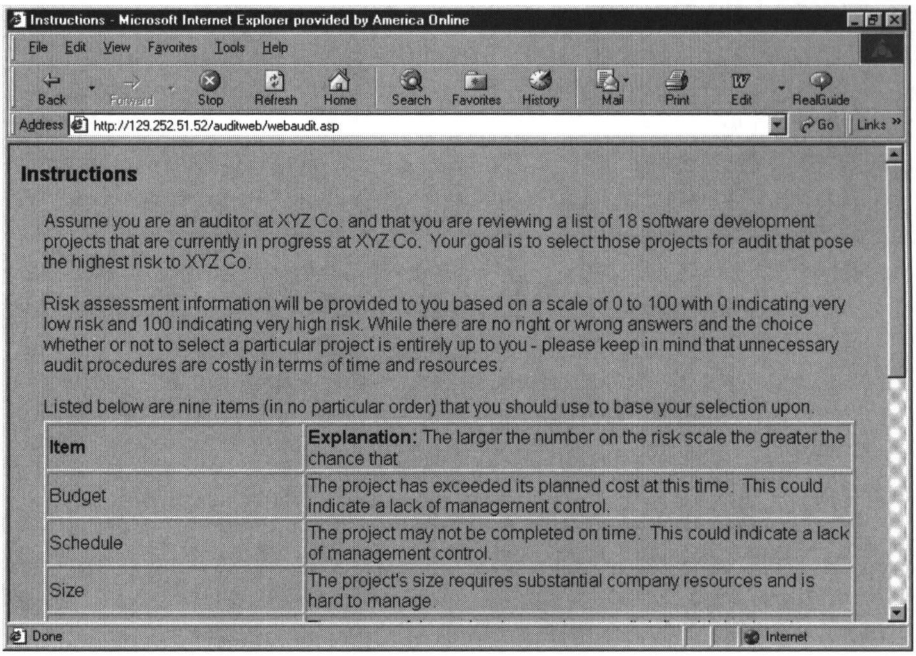
Wedell, D. H., & Senter, S. M. (1997). Looking and weighting in judgment and choice. *Organizational Behavior and Human Decision Processes, 70*(1), 41–64.

Zhang, G. P., Keil, M., Rai, A., & Mann, J. (2003). Predicting information technology project escalation: A neural network approach. *European Journal of Operational Research, 146*(1), 115–129.

APPENDIX A: RESEARCH INSTRUMENT

High Information Load/Time Pressure

Top of Page



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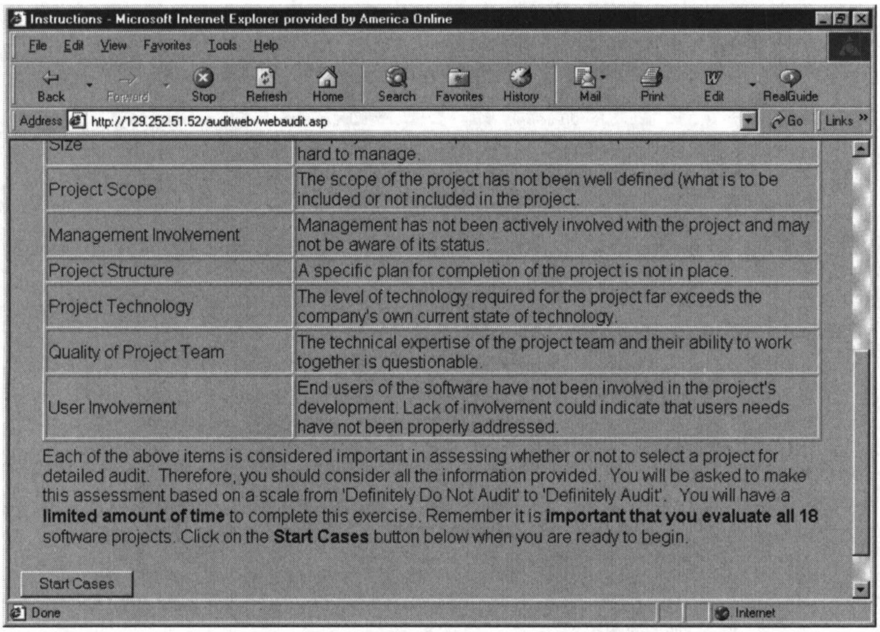
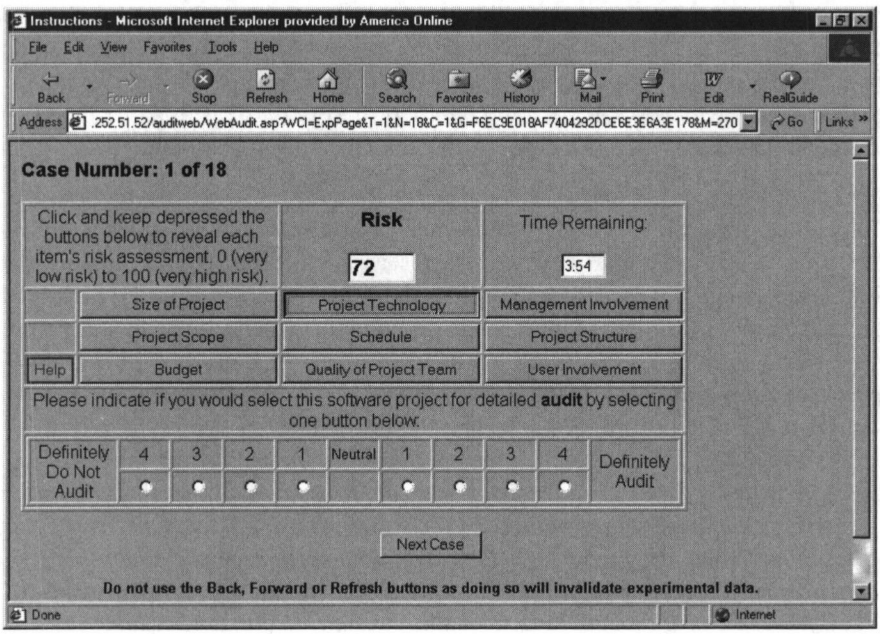
High Information Load/Time Pressure

Bottom of Page



High Information Load/Time Pressure

Cases



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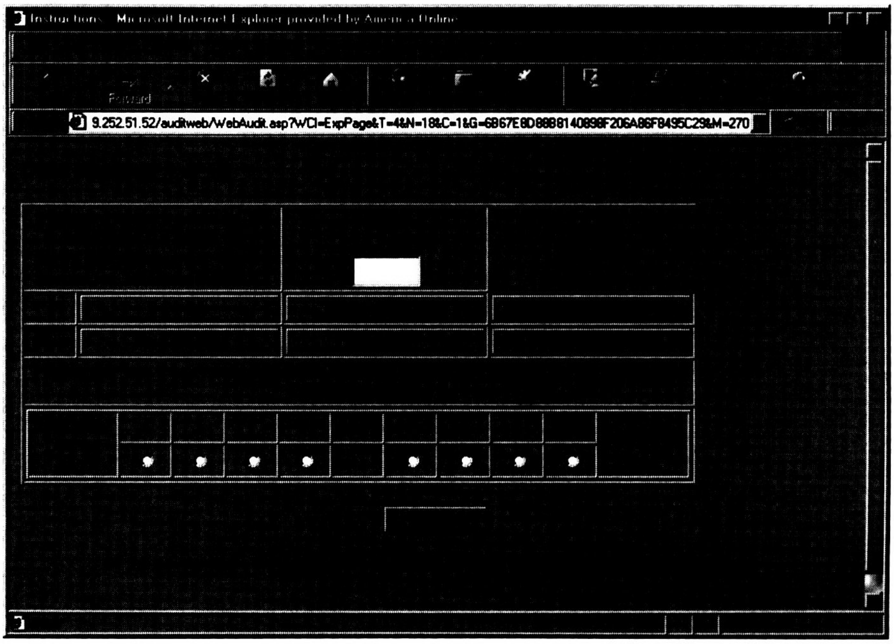
Low Information Load/No Time Pressure

Cases



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Brad Tuttle is a professor of accounting at the University of South Carolina's Moore School of Business. He teaches accounting information systems and information technology audit courses and researches information effects on individual and group behavior in accounting and information systems contexts. His research employs a variety of methods including field experiments, decision cases, and experimental economics, and his articles appear in both academic business and psychology journals including *Journal of Information Systems*, *The International Journal of Accounting Information Systems*, *Auditing: A Journal of Practice and Theory*, *Accounting, Organizations & Society*, *Contemporary Accounting Research*, *Journal of Behavioral Decision Making*, *Journal of Economic Psychology*, *Journal of Management Information Systems*, *Behavioral Research in Accounting*, *Advances in Accounting Behavioral Research*, *Journal of Forensic Accounting*, and *Advances in Accounting Information Systems*. He is a member of the American Accounting Association and the Information Systems Audit and Control Association.

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