12-14-2009

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Influence of project risk factors and self-efficacy on the perception of risk in troubled IT projects

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ABSTRACT

Past studies have indicated that if project managers are able to perceive project risks accurately, they may be less likely to continue failing IT projects. A computer simulation based experiment was carried out to investigate the influence of individual self-efficacy and project risk factors on the perception of risk in failing IT projects. Results indicated that project managers with higher self-efficacy are likely to perceive the risks of a failing project to be lower compared to those with lower self-efficacy even though same information about project progess was provided in both conditions. Further, the results suggested that project managers are likely to underestimate the risks of a project with endogenous risk factors as compared to a project with exogenous risk factors.

Keywords

Risk Perception, Self-Efficacy, Project Risk Management, IT Projects

INTRODUCTION

Many IT projects tend to go over budget and are completed late. Escalation of commitment in IT projects is often a problem where project managers may continue to persist with failing projects. Some of those projects get canceled eventually (Ewusi-Mensah and Przasnyski, 2001) but only after significant additional resources have been invested. Inadequate risk management has been identified as a contributing factor for many software project failures (Barki, Rivard and Talbot, 1993; Boehm, 1991; Charette, 1989). Strategies like evolutionary development have been advocated that assess project risk on an ongoing basis. Proper risk assessment could lead to early identification of a failing project and so appropriate action could be taken. If project managers are able to accurately assess the risks of a failing project, they may be less likely to escalate their commitment to the failing project (Keil, Tan, Wei, and Saarinen, 2000a; Keil, Wallace, Turk, Dixon-Randall, and Nulden, 2000b).

In their assessment of project risk, the project managers may go through a cognitive process of risk identification, risk classification and risk evaluation. Risk identification is about identifying the factors or events that could potentially have a negative impact on project outcomes. Risk classification involves explicit or implicit categorization of these variables. Risk evaluation is about assessing the likely impact of these variables or events on project outcomes. Several studies have focused on identification and classification of risk factors for software development projects (Barki et al., 1993; Boehm and Ross, 1989; Ropponen and Lyytinen, 2000; Keil, Cule, Lytinnen, and Schmidt, 1998; Tiwana and Keil, 2004; Wallace, Keil and Rai, 2004). However, not much attention has been paid on what specific factors may influence the risk perception of IT project managers. Keil et al. (2000b) investigated the influence of magnitude of potential loss, probability of failure and individual risk propensity on perception of risk. Keil et al. (2000b) found that while magnitude of potential loss and probability of failure influenced the perception of risk, individual risk propensity did not influence the risk perception. It is imperative to understand what specific factors may influence the risk perception of project managers.

Keil et al. (2000a) have proposed a comprehensive conceptual framework that considers the influence of personal, project, informational, and organizational factors on risk perception which in turn influences the willingness to continue a failing project. Drawing upon this framework, this study focused on the following research question: How do project risk factors and personal self-efficacy influence the perception of risk in a failing IT project?

HYPOTHESES

This section reviews the relevant literature and offers hypotheses on the influence of project risk factors and self-efficacy on risk perception.

Risk Perception

Individual risk taking is influenced by risk perception (Sitkin and Pablo, 1992; Sitkin and Weingart, 1995). Sitkin and Pablo (1992, p.12) define risk perception as the "decision maker's assessment of the risk inherent in a situation". Risk perception has also been defined as the assessment of a situation in terms of probabilistic estimates of the degree of situational uncertainty, how controllable that uncertainty is, and confidence in those estimates (Sitkin and Weingart, 1995, p.1575). Appropriate risk assessment can help project managers take remedial actions. Where such remedial actions are not likely to turn around a project, it can also help determine whether to scale down or even terminate a failing project. Keil and his colleagues (Keil et al., 2000a; Keil et al., 2000b) argue that if managers are able to perceive the risks of failure early on, they will be less likely to continue failing IT projects. In a set of studies Keil and his colleagues (Keil et al., 2000a; Keil et al., 2000b) found that higher degree of perception of risk was associated with lower commitment to a failing project.

Project Risk Factors and Risk Perception

Managers believe in post-decisional control, that they will be able to control a risky situation using their skills (Shapira, 1995). Shapira (1995, p. 80, italics original) quotes a manager in his study "Decision theory puts all the emphasis on the analysis leading to the moment of choice. While it is definitely important, my experience taught me that my ability to influence whatever goes on *after* the moment of choice is perhaps even more important." Controllability of potential outcomes is a key factor that determines individual's risk perception (Slovic, 1987; Vlek and Stallen, 1980). People prefer controllable risks over less controllable risks (Klein and Kunda, 1994). Helveg-Larsen and Shepperd (2001) cite studies that found that low perceived control was associated with higher personal risk estimates. Using an international Delphi study, Keil, Cule, Lyytinen and Schmidt (1998) identified the risk factors deemed most important by project managers in the U.S, Finland, and Hong Kong. Keil et al. (1998) classified software risk factors as having two dimensions: perceived importance and perceived control. Keil et al. (1998) found that project managers considered those risks that were often not under their direct control to be the most important.

This study classifies project risk factors based on the degree of managerial control over the risk factors. Endogenous risk factors are variables or events that can influence the project outcomes negatively such as project team morale, employee productivity, inadequate training, or inadequate project reviews. These are linked to project's internal factors and are under the direct control of the manager. Exogenous risk factors are due to external events or factors that influence the project outcomes negatively. These are often not under the direct control of a project manager such as environmental factors like governmental regulations, or change in business environment or change in project scope. Even though the potential negative impact of both the factors could be the same, project managers will tend to evaluate the risks of the endogenous risk factors to be lower as compared to the risks of exogenous factors due to their greater degree of perceived controllability over the endogenous risk factors. This leads to the first hypothesis:

H1: *Risk associated with endogenous risk factors will be perceived to be lower than that associated with exogenous risk factors.*

Self-efficacy and Risk Perception

Sitkin and Weingart (1995, p.1587) suggest that future research should investigate the link between self-efficacy and risk behavior. Sitkin and Weingart (1995) argue that outcome history has not been paid much attention in theories of risky decision making. Past performance influences self-efficacy which in turn can influence the endeavors individuals will undertake in future and the amount of risk they will be willing to undertake. Individuals with past history of successful risk taking tend to take greater risks (March and Shapira, 1987; Osborn and Jackson, 1988; Thaler and Johnson, 1990).

Heath and Tversky (1991) found support for the competence hypothesis that suggests that individuals' self-assessment of their knowledge or competence influences whether they seek ambiguity or avoid it. In their study participants who perceived that they had more knowledge or competence in a domain tended to be ambiguity seeking in making choices under uncertainty. Krueger and Dickson (1994) found that performance feedback influenced self-efficacy which in turn influenced risk taking behavior. Positive performance feedback increased the participants' self-efficacy, which in turn lead them to take greater chances in a gambling and dilemma task situation. On the other hand, negative performance feedback reduced participants' self-efficacy.This lead them to take lesser chances in the gambling and dilemma task situation. Whyte, Saks and Hook (1997) found that participants who had higher self-efficacy were willing to take greater chances to save the failing project.

Thus, self-efficacy may influence individuals' perception of risk in a given situation which in turn could affect the risks they are willing to accept. This leads to the second hypothesis:

H2: *Self-efficacy will influence risk perception such that project managers with higher (lower) task-specific self-efficacy will perceive the risks to be lower (higher) in a failing IT project.*

RESEARCH METHOD

This study used a laboratory experiment with a simulated software project providing a dynamic task scenario unfolding over time. DiFonzo, Hantula and Bordia (1998) suggest several advantages to computer simulation based microworlds in laboratory experiments: it can provide much greater task realism i.e. greater correspondence with the actual task and it can also provide much greater experimental realism i.e. greater degree of participant involvement. Further, compared to field studies, experiments based on microworlds can provide a certain degree of control (Brehmer and Dorner, 1993) so that one can manipulate the variables of interest. Unlike in field studies, one can more easily investigage how participants assess a situation in real time, such as how participants perceive the risks of a failing project as it unfolds over time.

Experimental Task and Materials

Participants were asked to play the role of a software project manager. Their goal was to execute a simulated project with a budget of $3 million to be completed within 60 weeks of simulated time. If the project were to get behind schedule, the benefits will be less. The simulated project was manipulated to create a forced-scenario of a failing project so that no matter what decisions participants made, it led to the outcome of a project that could not be completed within the 60 weeks of simulated time whereas almost all of its budget would have been spent. Further, the estimated benefits at the end of simulated 60 weeks were also much lower than the initial projections.

Experimental Design

The experimental design was 2x2x2x4 mixed factorial design with between-subjects manipulations of project risk factors (Exogenous/Endogenous risk factors) and the initial task-specific self-efficacy (TSSE) beliefs of participants (High/Low) before they worked on the failing project. Since data was collected in two phases with students participating in the first phase and experienced project managers participating in the second phase, participant category (students/project managers) was treated as a blocking factor. Through project reports, an increasingly negative feedback was provided to all participants indicating that the project could be on a path of failure. Thus, increasingly negative feedback provided over time served as a within-subjects factor. Same negative feedback was provided to all participants that were at the same stage. Thus, the differences in assessment of risks could be attributed not to differences in information about project progress but to experimental manipulations. Participants were asked to provide project reviews periodically at four stages within the simulated time duration. Repeated measures of participants' assessment of project status, perceived control, risk perception and commitment to the failing project were taken at those project reviews.

Self-efficacy is a task-specific construct as conceptualized by many researchers (e.g. Gist, Schwoerer, and Rosen, 1989) rather than a general trait. Before participants were assigned to work on the main task, they were asked to work on a practice task which was designed to manipulate their initial task-specific self-efficacy (TSSE) beliefs about the main task they were going to work on next. Verbal persuasion and past experience are two of the significant factors that influence individual's self-efficacy (Bandura, 1986). Participants assigned to the high initial TSSE condition were told that they were chosen to lead this project because they had significant experience in related projects. Further, these participants found that they were able to complete the project as a practice task on time and within budget. Participants assigned to the low initial TSSE condition were told that they did not have much experience in the domain. Further, these participants found out that they could not complete the project assigned as a practice task on time and within budget. Participants were then randomly assigned to work on one of the two main task scenarios that embedded the project risk factors. In the endogenous risk factor scenario, participants were told that they did not have enough experienced staff members. This was a risk factor within their direct control as participants, while working on the simulated project, could provide training or hire more experienced staff. Participants assigned to the exogenous risk factor scenario found that the project scope kept increasing and they had to live with it. So this was a factor not within their direct control.

Participants

20 undergraduate students, 16 graduate students, and 35 managers with varying degrees of experience in project management participated in the study. Student participants were familiar with the software development lifecycle and the basic concepts

of project management, either through coursework or having worked on software projects in the past. This made sure that participants understood the task.

Procedure

Having given their consent, participants were provided with background material to read that explained the organizational context and their role. Participants completed a tutorial that helped them understand what decisions they could made and what information was available to them within the simulated software project. Participants then had the opportunity to ask any questions about the simulation and obtain clarification. After that participants were requested to work independently on the task without interacting with the experimenter.

Participants then worked on a practice task that was designed to manipulate their task-specific self-efficacy beliefs, i.e. their confidence in their ability to execute the main task successfully. Participants then worked on the main task. As participants executed the project, they received periodic reports on project progress such as earned value measures, current project costs and projected benefits, project tasks completed, budget spent, and staffing levels. Participants needed to make two types of staffing decisions: whether to acquire or release project staff and determine the number of hours of training to be provided. Participants made decisions for a total of twelve decision periods with each decision period spanning five weeks of simulated time.

Measures

As participants executed the main project, participants were asked to review the project at the interval of every 15 weeks of simulated time. Data was collected through periodic reports that participants had to fill out. During the first three project reviews participants provided their assessment of risk. Measures of perceived project status, perceived control over the project, and commitment to the project were collected at all four project reviews including the last review when the project was scheduled to be completed at week 60.

Consistent with the approach used by Keil and colleagues (Keil et al., 2000a; Keil et al., 2000b), task specific measures of risk perception were used since this study attempts to measure the decision makers' perceptions in response to a specific task scenario. Keil et al. (2000b) had measured participants' risk perception by asking them to assess the overall riskiness of the project whereas Keil et al. (2000a) had measured participants' risk perception by asking participants to assess the amount of risk and probability of success associated with the failing project. Risk is often measured through the combination of the probability that an undesirable event can occur and the magnitude of loss associated with the undesirable event (Dunegan, Duchon and Barton, 1992; Mellers and Chang, 1994). A measure that captures both these aspects of risk can provide a better measure for risk perception as compared to assessment of the amount of risk associated with a project.

A six-item risk perception scale was created. The construct of risk perception was operationalized through participants' assessment of: i) likelihood that the project will meet the budget goal ii) likelihood that the project will meet the schedule goal iii) estimate of cost overrun iv) estimate of schedule overrun and v) probability of project success and vi) overall risk. The first two items tap into the 'likelihood of negative outcomes' dimension of the risk construct whereas the next two items tap into the 'magnitude of potential loss or negative outcomes' dimension of the risk construct. The remaining two items measure the overall riskiness of the project.

RESULTS

This section presents the results of data analysis done to test the hypotheses offered earlier.

Manipulation Checks

The participants' initial task specific self-efficacy (TSSE) and project risk factors have been manipulated in this study as between-subjects factors. Participants were provided negative feedback over time to indicate a failing project. This was a within-subjects factor. Manipulation checks suggested that the experimental manipulations were successful.

Task Specific Self-Efficacy

Table 1 shows the respective means and standard deviation of responses to the 2-item TSSE scale and the one item measuring the confidence to complete the project successfully. After completing the practice task, participants read the background information about the main project, Project Alpha. Before the participants began the main task, participants responded to a 2-

item TSSE scale that asked them how confident they were in their ability to complete project Alpha: i) within the scheduled time frame and ii) within the budgeted cost. As an overall measure, a third item also asked participants how confident they were to be able to complete the project successfully. The scales were anchored by 1 (strongly disagree) to 7 (strongly agree) with higher values indicating greater confidence in ones ability. These three questions served as a manipulation check.

Measure	All Groups	Initial TSSE		Participant Category	
		High	Low	S	P
Item1 - Confidence to complete the project on schedule	4.85 (1.12)	5.21 (0.93)	4.5 (1.19)	4.69 (1.21)	5.03 (.98)
Item2 - Confidence to complete the project within budgeted cost	4.25 (1.13)	4.94 (.97)	3.59 (.86)	4.14 (1.2)	5.03 (.98)
Item3 - Confidence to complete the project successfully	4.91 (1.177)	5.30 (1.104)	4.53 (1.134)	4.69 (1.215)	5.16 (1.098)
N	67	33	34	36	31

Equal variances assumed. Levene's test not significant. S - Students Block, P – Project Managers Block

Table 1. Means (and Standard Deviations) of manipulation check items

Results of multivariate analysis of variance (MANOVA) revealed significant differences between participants' response to questions about their confidence in their ability to complete the project i) within the scheduled time frame ($F (1,65) = 7.46$, $p < .005$), ii) within the budgeted cost ($F (1,65) = 36.72$, $p < .001$), and iii) successfully ($F(1,65) = 7.99$, $p < .01$). Individual t-tests were conducted to test between group differences. Compared to participants in the Low Initial TSSE group, participants in the High Initial TSSE group had significantly higher confidence level in their ability to i) complete the project on schedule, $t (65) = 2.731$, $p < 0.01$, ii) complete the project within the budgeted cost, $t (65) = 6.06$, $p < 0.001$, and iii) complete the project successfully, $t (65) = 2.828$, $p < 0.01$. Project managers were slightly more confident about their ability to complete the project successfully as compared to students but it was not significant statistically, $t (65) = -1.64$, $p = .106$.

Project Risk Factors

A single item measured perceived controllability of project outcomes to check the manipulation of project risk factors: whether participants believed that the project outcomes were due to factors within their control or not. The item was anchored by strongly agree (7) to strongly disagree (1) on a 7 point scale. The responses were reverse coded so higher value indicated that participants believed the project outcomes were greater under their control. Using perceived controllability as the dependent measure, univariate ANOVA was performed with project risk factors (Endogenous/Exogenous), initial TSSE (High/Low) as the fixed factors and participant category (Students / Project Managers) as a blocking factor. It revealed that the manipulation of the task scenario with endogenous or exogenous risk factors was successful. There were significant differences between participants assigned to endogenous and exogenous risk factor scenarios in their beliefs about controllability of project outcomes, $F (1,65) = 4.3$, $p < .05$.

Perceived Project Status

To test whether participants perceived the project status increasingly negative as the project unfolded, participants were asked to provide their assessment of the project status on a 3-item Perceived Project Status scale as part of periodic project review. Perceived Project Status score was obtained by averaging the scores of the 3-item scale. To test whether the participants perceived the project status to be progressively negative as the project unfolded, 2x2x2x4 repeated measures ANOVA was conducted with Initial TSSE (High/Low) and Project Risk Factors (ENDO/EXO) as between-subjects factors, Participant category (Students/Project Managers) as a blocking factor and Review Period as the within-subject factor. The repeated measures analysis revealed a significant main effect of project review periods on assessment of project status i.e. participants' perception of the project status changed significantly across the review periods. Thus, the within-subjects manipulation of

negative feedback across time was successful. Between-subjects test revealed no significant differences between participant groups in how they perceived the project status.

Psychometric Properties of Measurement Scales

The measurement scales used have adequate psychometric properties. Cronbach's α for the 2-item initial TSSE scale was .754. Principal component factor analysis of the six-item risk perception scale revealed that item#4 (estimate of final cost) loaded on another factor in two out of the three time periods. The variance explained ranged from 62.85% - 68.16%. Cronbach's α across the three time periods ranged from .721 to .729 (standardized). The reliability of the scale could improve if item#4 was dropped from the scale. Hence it was dropped from the scale for further analysis. The items in the risk perception scale were on different measurement scales. Hence it was necessary to convert the scores to a common scale using an appropriate transformation. The raw item scores were converted to z-scores for each item using the mean and standard deviation for the combined data for all three periods. The score for risk perception was obtained by averaging the remaining five item scores. For easier interpretation, the score was linearly transformed using the formula $riskper_i = Zriskper_i * 20 + 100$, $i = 1$ to 3.

Influence of Project Risk Factors and Self-Efficacy on Risk Perception

Hypotheses H1 and H2 propose the respective influence of project risk factors and self-efficacy on risk perception. To test these hypotheses, a 2x2x2x3 repeated measures ANOVA was performed with Initial TSSE (High/Low) and Project Risk Factors (Endogenous/Exogenous) as between-subjects factors, Participant Category (Students/Project Managers) as a blocking factor and Project Review Period as the within-subject factor. The analysis revealed that there were significant main effects of project risk factors and self-efficacy on risk perception.

Participants in the exogenous risk factor scenario perceived the risk to be significantly higher as compared to participants in the endogenous risk factor scenario ($F (1,64) = 4.91$, $p < .05$) providing support to hypothesis H1. Participants who had higher initial TSSE had significantly lower risk perception as compared to participants who had lower initial TSSE ($F (1,64) = 4.53$, $p < .05$) providing support to hypothesis H2. There was no interaction between project risk factors and self-efficacy. Further, participants' risk perception increased significantly over time as project performance had deteriorated.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	2063078.6	1	2063078.6	6169.05	.000
Initial TSSE	1515.2660	1	1515.26	4.53	.037[1]
Project Risk Factors	1642.9065	1	1642.90	4.91	.030[2]
Participant Category	24.19	1	24.19	.07	.79
Initial TSSE*Project Risk Factors	236.8	1	236.8	.71	.403
Error	21403.15	64	334.42		

[1]Observed power = .554; [2]Observed power = .588

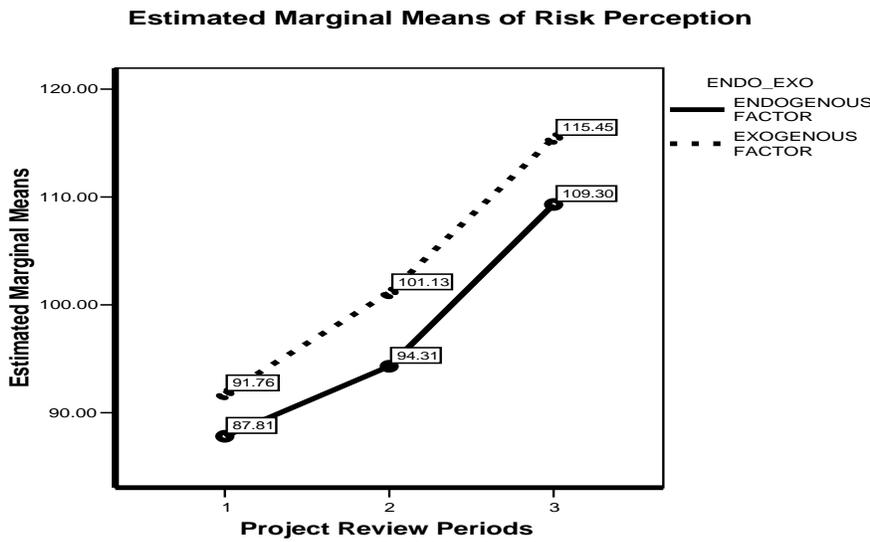**Table 2. Tests of Between-Subjects Effects on Risk Perception**

Estimated Marginal Means of Risk Perception

Figure 1. Risk Perception between Endogenous Risk Factor Scenario and Exogenous Risk Factor Scenario Groups

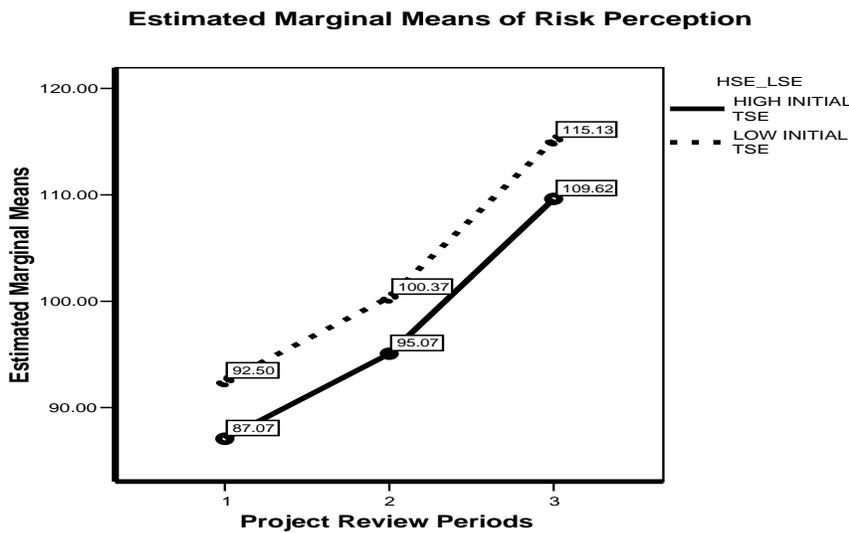**Estimated Marginal Means of Risk Perception**

Figure 2. Differences in Risk Perception between High Initial TSSE and Low Initial TSSE groups

DISCUSSION

Decision makers who have high self-efficacy built on past successes may believe that they will be able to replicate their past success in a new situation and may underestimate the risks inherent in a situation. There is some evidence from past studies that self-efficacy influences the perception of risk in a given situation. Results from data analysis indicate that compared to participants with lower initial task specific self-efficacy (TSSE), participants with higher TSSE had lower levels of risk perception, even though the same feedback was provided to everyone. Thus, the results provided support for the link between

self-efficacy and risk perception. This means that, other things being equal, individuals with high self-efficacy could be more optimistic in their evaluations of the risks in a given situation.

Literature in managerial risk taking has suggested that managers believe in post-decisional control and evaluate a risk factor from the view point of whether they have control over it or not. Participants who faced an exogenous risk factor scenario had assessed the project risk to be much higher as compared to participants who faced an endogenous risk factor scenario. Both project risk factors as well as self-efficacy influenced risk perception. However, no interaction was found between self-efficacy and project risk factors.

No significant differences were found between responses of students and project managers in terms of their assessment of risk or their assessment of project status over time. It could be due to the fact that while the simulated project was more complex than the case vignettes used in most laboratory studies on IT projects (e.g. Keil et al., 2000a; Keil et al., 2000b), the task had to be simplified. This had to be done for several reasons: The entire experiment had to be completed within a two hour time frame so that participants could still remain engaged with the task and fatigue effects do not set in. Further, the task had to be simplified so that even undergraduate students with the foundational knowledge of software development and project management could complete the task. The pilot tests had indicated that the basic knowledge of software development lifecycle and project management concepts was sufficient for participants to complete the task. Future studies could investigate whether the results generalize to tasks that are more complex, where participants need to invoke domain specific or experiential knowledge of project management.

Theoretical Significance

Few studies have focused on understanding of the factors that influence managerial risk perception in the context of IT projects. Keil et al. (2000a) have proposed a multi-level framework that captures organizational, project level, individual factors that may influence risk perception. This study builds on the work of Keil and his colleagues (Keil et al., 2000a; Keil et al., 2000b) and makes a contribution by investigating the influence of a project level factor such as the controllability of project risk factors and an individual factor such as individual self-efficacy on the perception of risk.

Methodological Significance

Few studies have used dynamic task scnenarios to investigate decision making in failing projects. Computer simulation based task scenarios enable participants to revise their situation assessment as the situation unfolds over time. Most laboratory experiments that investigate decision making in failing projects have used paper and pencil based tasks that allow only one-shot judgment of the situation.Participants do not have the opportunity to revise their assessment as more information is available. This study uses a dynamic task scenario of a failing software project which provides a richer context to investigate how project managers assess the risks of a failing project.

Further, past studies that investigated risk perception in IT projects (Keil et al., 2000a; Keil et al., 2000b) have used an overall measure of risk by asking participants how much risk was associated with the project. In order to better understand how individuals assess risk in a given situation, it is important to consider the underlying dimensions of risk assessment. In this study, risk perception was measured by assessing how participants estimated the likelihood as well as the magnitude of negative outcomes along with asking them to provide an overall measure of risk and the likelihood of success. This leads to a comprehensive assessment of risk perception.

Additionally, Whyte, Saks and Hook (1997) in their study had used verbal persuasion to manipulate self-efficacy beliefs of participants. However, past experience can provide a stronger manipulation of self-efficacy than verbal persuasion alone. In this study the practice task served to provide a direct experience of the task facing the participants and hence provided more powerful influence on their self-efficacy beliefs.

Practical Significance

One of the pressing dilemmas for project managers is deciding whether to recommend continuing or terminating a failing project. Inaccurate risk perceptions can lead to persistence with a failing course of action even though withdrawal would have been a better option. Having an accurate assessment of risk is not only important for project continuation decisions but also for project launch decisions too. If decision makers with high self-efficacy evaluate a risky project more optimistically, it is possible that the project may fail later on. On the other hand decision makers with low self-efficacy may not launch risky but promising projects.

Limitations

There are some limitations of this study. The simulated software project followed a structured, waterfall development approach. Whether the results of this study will generalize to software projects that follow a different developmental approach needs to be tested empirically. The small sample size of this study is also a limitation. This study involved participation from both students and project managers and there were specific requirements for participation. The student participants needed to have an understanding of software development lifecycle and the basic concepts of project management. The decreasing enrollment in the IS programs in recent years had reduced the number of potential participants for the study. Further, only one participant was scheduled at a time since verbal protocol data was also collected while the participants worked on the task.

CONCLUSION

The study suggests that while past experience in the project domain may perhaps help project managers in assessing the risks more accurately than novices (Du, Keil, Mathiassen, Shen and Tiwana, 2007), it could also work the other way. Project managers with high self-efficacy may overgeneralize their past experiences to new situations and underestimate the risks involved. Further, project managers might underestimate the risks associated with endogenous risk factors as they may believe that they have greater control over those risk factors.

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