An investigation of risk perception and risk propensity on the decision to continue a software development project

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Abstract

Many information system (IS) failures may result from the inadequate assessment of project risk. To help managers appraise project risk more accurately, IS researchers have developed a variety of risk assessment tools including checklists and surveys. Implicit in this line of research, however, is the assumption that the use of such devices will lead to more accurate risk perceptions that will, in turn, lead to more appropriate decisions regarding project initiation and continuation. Little is known, though, about the factors that influence risk perception or the interrelationships that exist among risk perception, risk propensity, and decisions about whether or not to continue a project. Without a better understanding of these relationships it is difficult to know whether the application of risk instruments will be an effective means for reducing the incidence of IS failure. This study presents the results of a laboratory experiment designed to: (1) examine the relative contribution of two factors that are believed to shape risk perception: probability that a loss will occur and the magnitude of the potential loss, and (2) explore the relative influence of risk perception and risk propensity on the decision of whether or not to continue a software development project. The results indicate that magnitude of potential loss is the more potent factor in shaping risk perception and that a significant relationship exists between risk perception and decision-making. The implications of these findings are discussed along with directions for future research. © 2000 Elsevier Science Inc. All rights reserved.

Keywords: Software project; Risk perception; Risk propensity; Decision-making

1. Introduction

While there are undoubtedly success stories in the information systems (IS) area, the sad fact remains that many software development projects end in failure (Lyytinen and Hirschheim, 1987; Jones, 1995). Descriptions of such failures appear regularly in business press reports (Rifkin and Betts, 1988; Kindel, 1992; Cringely, 1994; Gibbs, 1994; Tomsho, 1994). As a result, both researchers and practitioners have expressed concerns about how to manage IS project risk (Keider, 1974; Ginzberg, 1981; Boehm, 1991; Barki et al., 1993; Lyytinen et al., 1993; Jones, 1994).

Many researchers have suggested that inadequate assessment of project risk may be a major source of problems in IS development (Alter and Ginzberg, 1978; Ginzberg, 1981; McFarlan, 1981; Charette, 1989; Boehm, 1991; Barki et al., 1993). One approach for avoiding failure lies in the concept of software development risk management. Advocates of this approach claim that by identifying and analyzing threats to success, action can be taken to reduce the chance of failure.

The software risk management advocates would argue that managers may not accurately perceive risks, causing them to pursue IS projects that ultimately result in failure. If managers have faulty perceptions of risk, then their
management efforts are likely to be misdirected (Slovic et al., 1981). Furthermore, when managers do not formally assess risks they may underestimate them and unknowingly make risky decisions. Within the IS literature, several checklists and instruments have emerged to help managers assess and manage software development risk. McFarlan (1981), for example, has developed a series of questions designed to gauge the riskiness of an IS project. Boehm and Ross (1989) provide a “top-ten” list of risk factors that can be used as a checklist for identifying risks that can adversely affect IS projects. More recently, Barki et al. (1993) have published a risk assessment instrument designed to measure the risk associated with an IS development project.

Risk assessment devices, such as the ones mentioned above, will be useful to organizations if they allow managers to more effectively assess and manage the risk associated with IS development (Barki et al., 1993; Lyytinen et al., 1993; Ropponen and Lyytinen, 1993). Implicit in this line of research, however, is the assumption that risk assessment devices will provide managers with more accurate perceptions of the risk associated with a project, thereby allowing them to make better informed decisions and ensuring more successful outcomes (McFarlan, 1981; McComb and Smith, 1991). In order for this to be true, however, the following relationships must hold: (1) risk assessment devices must have the intended effect on risk perception (i.e., a heightened awareness and sensitivity to the risks involved), and (2) changes in risk perception must translate to changes in decision-making. To date, neither of these relationships have been explicitly studied in an IS project context and therefore it would be premature to conclude that risk assessment instruments will actually help managers to avoid or minimize IS project failure.

The rest of the paper is organized into five sections. The first two sections provide a brief review of the relevant constructs and introduces the research model, questions, and hypotheses. This is followed by a description of the research method used and the results obtained from the study. The paper concludes with a discussion on the implications of the study along with directions for future research.

2. Background

In decision theory a risk may lead to either positive or negative consequences (Arrow, 1970). Although Charette (1989) defines software risk along decision-theoretic lines, most of the software risk management literature has focused only on the negative consequences associated with a course of action (Barki et al., 1993). Consistent with this focus on negative outcomes, we define risk as the non-zero probability that one or more undesirable outcomes will occur; in other words, there is some likelihood of a loss. A loss would mean that an individual (or organization) is deprived of an outcome they already possess or might have acquired (Yates and Stone, 1992). In summary, risk is generally regarded as being composed of two components (Barki et al., 1993): (1) the probability that a loss will occur, and (2) the significance or magnitude associated with the possible loss. The first factor—probability of loss—means that an event is considered risky if its outcome is not certain, but that it may result in a loss. As this probability increases, the risk level increases. The second factor—magnitude of loss—means that the more significant the potential loss, the greater the implied risk.

Therefore, risk generally can be regarded as the combination of the probability of an undesirable event occurring and the magnitude of the loss that is associated with the event (Mellers and Chang, 1994). These two factors have often been used together to define and describe risk (Sjoberg, 1980; Boehm, 1991; Haimes, 1991; Collins and Ruefli, 1992; Yates and Stone, 1992; Sherer, 1994), but little is known about the relative impact of these two factors in shaping risk perception.

While there are many different factors that may affect decision-making, two variables—risk perception and risk propensity—appear to play a central role in decision-making involving risk. Risk perception has been defined as “a decision maker’s assessment of the risk inherent in a situation” (Sitkin and Pablo, 1992, p. 12). Risk propensity refers to the notion that many decision makers have consistent tendencies to either take or avoid actions that they feel are risky (Kogan and Wallach, 1964; Harnett and Cummings, 1980; Sitkin and Pablo, 1992).

Although previous research has investigated separately the effect of each of these factors on decision-making, comparatively little is known about the relative contribution of these two factors in shaping decisions involving risk. There is only one study that we are aware of which has examined the effects of both risk propensity and risk perception on decision-making (Sitkin and Weingart, 1995). It is important to note that even the Sitkin and Weingart (1995)
study, however, did not examine these constructs in an IS project context. Since there is evidence that individual risk propensity can vary dramatically from one situation to another (MacCrimmon and Wehrung, 1985), this suggests the need for further research to determine if the results obtained by Sitkin and Weingart (1995) can be generalized to an IS project context. The rest of this section reviews prior research on the risk perception and risk propensity constructs, how they inter-relate, and the impact they may have on decision-making.

2.1. Risk perception

Before discussing the impact of risk perception on decision-making, it is first necessary to understand how individuals assess, or perceive, risk. Previous research has indicated that perceptions are affected by the degree of risk associated with a situation. Based on our previous discussion of what constitutes risk, this would imply that an individual’s risk perception in a given situation will be a function of both the probability of a loss occurring as well as the potential magnitude of such a loss should it occur (Dunegan et al., 1992; Mellers and Chang, 1994). In a review of managerial perspectives on risk-taking, March and Shapira (1987) suggest that the magnitude of potential loss is the more salient of the two factors in the minds of managers. However, there have been no controlled studies on the relative impact of these two factors on risk perception.

2.2. Risk perception and decision-making

While numerous studies have been conducted on decision-making, there appear to be few examples in which risk perception was either directly manipulated or actually measured. Instead, most studies have emphasized the role that framing and other factors can have on decision-making. Framing effects occur when choices with the same expected values are described in ways that elicit different decision-making behavior (Kahneman and Tversky, 1984). Presumably, the framing effect occurs because it evokes a change in risk perception. In addition to the framing effect, other research suggests that decision-making can be influenced by the nature of the task (Slovic, 1972), the subject’s familiarity with the problem domain (Slovic et al., 1982), affect (Dunegan et al., 1992), and self-efficacy (Krueger and Dickson, 1994). Most of the above factors presumably have an indirect effect on decision-making which are expressed through changes in risk perception.

Thus, while numerous studies have been conducted on decision-making, there appear to be few examples in which risk perception was actually measured. Instead, researchers have indirectly manipulated risk perception (by altering problem framing, for example) and then measured variations in decision-making. As a result, previous studies make it difficult to determine the extent to which risk perceptions affect decision-making.

Although researchers generally agree that there is a relationship between perception and decision-making (Keyes, 1985; Bromily and Curley, 1992; Krueger and Dickson, 1994; Sutcliffe, 1994), there are inconsistencies concerning the nature of the relationship. One would expect that as the level of perceived risk increases, a person is less likely to engage in risk-taking behavior (Staw et al., 1981; March and Shapira, 1987; Dunegan et al., 1992), but there is evidence indicating that this is not always the case. For example, Kahneman and Tversky (1979) have found that under negative problem framing, decision-makers perceiving high levels of risk respond with risk-seeking behavior.

In summary, the exact nature of the relationship between risk perception and decision-making is not known for two reasons. First, although many studies have manipulated factors that appear to affect people’s risk perceptions and change their decision-making, very few studies have directly measured risk perceptions. Second, the nature of the relationship between risk perception and decision-making does not appear to be entirely consistent across studies. We turn now to the relationship between risk propensity and decision-making.

2.3. Risk propensity and decision-making

An individual’s propensity to take or avoid risks may have a significant impact on decision-making under conditions of risk and uncertainty. It has been commonly observed that people differ in their willingness to take risks (Fishburn, 1977; MacCrimmon and Wehrung, 1990; Farmer, 1993; Fu, 1993), but there is disagreement about the nature of this trait and the impact it has on decision-making.

One possibility is that risk propensity is a general personality trait which causes individuals to demonstrate consistent risk-seeking or risk-averse tendencies across a variety of situations. This possibility has led to the development of instruments which attempt to measure an individual’s general risk propensity (Kogan and Wallach, 1964; Jackson et al., 1972; Harnett and Cummings, 1980). For example, Keinan et al. developed a risk propensity instrument in an attempt to identify individuals who have high risk-taking propensities (Keinan and Gome-Nemirovsky, 1984). They based the development of their instrument on the “assumption that risk-taking is an expression of personality traits
that affect individuals beyond situational variables” (Keinan and Gome-Nemirovsky, 1984, p. 163). Similar instruments have been used in a number of studies and the results have suggested that individuals have a general risk propensity which affects their decision-making under conditions of risk or uncertainty (Taylor and Dunnette, 1974; Ghosh and Ray, 1992; Kim, 1992).

Other studies, however, have found risk propensity to be a situationally-specific variable, meaning that an individual’s risk propensity will not be the same in every situation (MacCrimmon and Wehrung, 1985). A large number of researchers have found no evidence of a general risk propensity across situations (Slovic, 1962; Kogan and Wallach, 1964; Higbee, 1971; Slovic, 1972; Keyes, 1985; MacCrimmon and Wehrung, 1990). Rather, the bulk of the evidence shows more support for “the importance of situational factors than support for the notion of risk-taking propensity as a stable trait” (Slovic, 1972, p.133). Therefore, in order to predict an individual’s decision-making in a particular risk context, it is necessary to examine the individual’s risk propensity in a similar situation (MacCrimmon and Wehrung, 1985). This suggests, for example, that if one is interested in predicting decision-making in an IS project context, then it is necessary to examine risk propensity in situations concerning IS project decision-making. We turn now to the relationship between risk propensity and risk perception.

2.4. The relationship between risk propensity and risk perception

Although risk propensity and risk perception both appear to influence decision-making, there is also evidence indicating that they interact with each other as well. More specifically, it appears that risk propensity may have an impact on risk perception. For example, if an individual has a high risk-taking propensity, he/she may tend to underestimate the risks involved in a situation. A risk-seeking decision maker is more likely to recognize and weigh positive outcomes, thereby overestimating the probability of a gain relative to the probability of a loss (Brockhaus, 1980; Vlek and Stallen, 1980). This overestimation will result in a lowering of risk perceptions. Additionally, a risk-averse decision maker will weigh negative outcomes more highly, leading to a heightened perception of risk (Schneider and Lopes, 1986).

2.5. Risk perception, risk propensity, and decision-making

The exact nature of the relationship between risk perception, risk propensity, and decision-making is not well-understood. While prior research has examined the effects of risk perception on decision-making and the relationship between risk propensity and decision-making, we know of only one study that has examined all three constructs together (Sitkin and Weingart, 1995). In this study, Sitkin and Weingart (1995) conducted laboratory experiments in which they manipulated outcome history and problem framing while measuring risk propensity, risk perception, and decision-making. The results of their study suggest that risk propensity is inversely related to risk perception which, in turn, is inversely related to the tendency to make risky decisions. No significant effect was found between risk propensity and decision-making. While consistent with some of the previous literature, these findings are not entirely consistent with a previous model proposed by Sitkin and Pablo (1992), in which risk propensity was hypothesized to be a major determinant of decision-making under risk. Because of this inconsistency and because of the lack of other empirical studies on the inter-relationships between these three constructs, there is a clear need for further study to see if the results obtained by Sitkin and Weingart (1995) are replicable.

3. Research model, questions, and hypotheses

Based on the above review of the literature, we elected to focus on two key areas that require further investigation: (1) the relative impact of probability of loss vs. magnitude of loss in shaping risk perception, and (2) the exact nature of the relationship between risk perception, risk propensity, and decision-making. The underlying research model is shown in Fig. 1.

Understanding the factors that influence risk perception and the nature of the relationship between risk perception, risk propensity, and decision-making is critical to the development of effective strategies for reducing IS project failure. Thus, the underlying research questions that this study sought to address were:

RQ1: Which factor-probability that a loss will occur or magnitude of potential loss-has the greater impact on risk perception?

RQ2: What is the nature of the relationship between risk perception, risk propensity, and decision-making in an IS project context?
Based on the above research questions and a review of the risk literature, the following hypotheses were formulated:

H1: Magnitude of potential loss will have a greater impact than the probability of a loss occurring on risk perception.

H2.1: There will be a significant negative relationship between risk perception and the decision to continue a software development project.

H2.2: There will be a significant positive relationship between risk propensity and the decision to continue a software development project.

H2.3: There will be a significant negative relationship between risk propensity and risk perception. For example, decision-makers having a risk-seeking propensity will perceive risks to be lower than decision-makers having a risk-averse propensity.

The first hypothesis is consistent with observations reported by March and Shapira (1987). If H1 is supported, this would offer confirmatory evidence that the magnitude of potential loss is a more influential factor than the probability of a loss occurring in shaping risk perceptions.

H2.1 and H2.2 will allow us to identify either risk perception, risk propensity, or both risk perception and risk propensity as the driving forces behind an individual’s decision-making under risk. H2.1 corresponds to the preponderance of evidence in the literature suggesting that individuals will exhibit risk-averse behavior when risks are perceived to be high and risk-seeking behavior when risks are perceived to be low.

Since risk propensity appears to be context specific, by measuring an individual’s risk-taking propensity in an IS project context and then asking them to make another IS project-related decision we expect to find a significant positive relationship between propensity and the decision to continue, as indicated by H2.2.

H2.3 indicates that an individual’s perception of risk in a given situation is dependent upon their propensity to take or avoid risks. This relationship has been previously proposed and supported in the risk literature (Brockhaus, 1980; Vlek and Stallen, 1980; Schneider and Lopes, 1986).

4. Research method

A laboratory experiment was selected as the most appropriate methodology for addressing our research questions. This approach allowed for a high degree of control and enabled us to test the four hypotheses of interest.

4.1. Experimental design

The experiment employed a $3 \times 3$ factorial design in which probability of failure and magnitude of potential loss were manipulated as independent variables. These two factors were used to vary the level of risk in the experiment. Both probability of failure and magnitude of potential loss were manipulated as “low”, “medium”, or “high,” as explained below. The resulting nine treatment conditions are shown in Fig. 2.

The experiment involved a one-page case scenario (shown in Appendix A) in which subjects were asked to play the role of a software project manager in a computer software company. Subjects were told that they were responsible for the development of a system being produced for external sale. They were also told the system was currently undergoing a standard review that included a risk assessment.

The risk assessment consisted of two informational components – probability of failure and magnitude of potential loss – which were presented to the subject in the form of a table. The first component, probability of failure, was operationalized as 25%, 50%, or 75%; these figures were designed to represent low, medium, and high probabilities of failure and were chosen based on pilot experiments. “Failure” was defined to mean that the sales of the product would
not produce enough money to offset the costs of development. The second component, magnitude of potential loss, was operationalized as the level of loss that the company would experience if the software project failed. The operationalization of low, medium, and high levels for this variable was as follows:

- **Low**: The failure of this project will have little or no effect on the company’s position or ability to survive.
- **Medium**: The failure of this project will have a significant effect on the company’s financial position, but not on the company’s ability to survive.
- **High**: The failure of this project will have a significant effect on the company’s financial position and will threaten the company’s ability to survive.

Immediately following exposure to the experimental materials, a manipulation check was employed to insure that subjects were responding to the manipulations of the two independent variables as planned. Subjects’ risk perceptions of the project described in the scenario were then measured and subjects were asked to make a decision regarding whether or not the project described in the scenario should be continued. In addition, the subjects were asked to write a short paragraph explaining the reasoning behind their decision. Prior to the experiment itself, subjects were asked to complete a short instrument designed to measure their risk propensity in an IS project context.

### 4.2. Subjects

The subjects who participated in this study were undergraduate business students enrolled in multiple sections of an introductory IS course at a large urban university. While student subjects can sometimes limit external validity (Gordon et al., 1986; Hughes and Gibson, 1991), the literature suggests that students are an appropriate surrogate for managers when the tasks being studied involve basic human information processing and decision-making tasks (Ashton and Kramer, 1980; Dunegan et al., 1992). In a study designed to assess the suitability of using business students as surrogates for managers in decision-making situations, Remus (1986) found no significant differences between student and manager groups. Thus, the use of students as subjects in this study is justifiable on the grounds that we are studying basic human information processing.

A total of 242 subjects participated in the experiment yielding a mean of 27 subjects per treatment condition. Fig. 3 contains the descriptive statistics for the subjects used in the study. The sample contained an approximately equal number of male and female subjects. While the subjects were students, they had an average of more than four years of work experience. This is due to the fact that the experiment was administered at a university that caters to students who work full-time and attend classes in the evening.

The experiment took place during the students’ regularly scheduled class time. Participation was entirely voluntary and the responses were kept anonymous. The students were told that they were being asked to participate in a study involving business decision-making. Those who participated were asked to complete an informed consent form. Students were then randomly assigned to one of the nine treatment groups. The students in six of the eight participating class sections (187 of 242 students) received extra credit for participating in the study and thus had an incentive to participate in the study. No statistical differences, however, were found among those students who received extra credit and those who did not.

![Fig. 2. The 3 x 3 factorial design.](image-url)

<table>
<thead>
<tr>
<th>Item</th>
<th>Valid</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>236</td>
<td>24.8</td>
<td>6.1</td>
<td>18</td>
<td>51</td>
</tr>
<tr>
<td>Work experience (years)</td>
<td>235</td>
<td>4.8</td>
<td>5.3</td>
<td>0</td>
<td>28</td>
</tr>
</tbody>
</table>

Fig. 3. Descriptive statistics on subjects.
4.3. Measures

Risk perception was measured using two Likert-type questions in which subjects were asked to indicate their perception of the overall risk associated with the software development project described in the scenario (see Appendix B). Since we were interested in measuring subjects’ perceptions in response to a specific risk scenario, the items were created and customized for this purpose as no suitable existing measures could be found. The practice of constructing scenario specific measures is consistent with prior research on risk perception (see, for example, Sitkin and Weingart, 1995). A reliability analysis was performed and the Cronbach’s alpha for the two perception items was found to be 0.95. The two risk perception items were therefore combined into an aggregate measure by calculating a simple average of the two items.

The measures of risk propensity were based on the choice dilemma questionnaire (CDQ) developed by Kogan and Wallach (1964). The CDQ consists of scenarios that describe situations involving a choice dilemma between a risky and safe course of action. A subject is asked to indicate the minimum odds of success they would demand before recommending the riskier alternative. The instrument is semi-projective in that the subject is asked to advise others in the situations described. It is assumed that advice to others reflects individual preferences (Kogan and Wallach, 1964). The CDQ has been used frequently and successfully as a measure of an individual’s risk propensity (Brockhaus, 1980; Fagley and Miller, 1990; Ghosh and Ray, 1992). Given the context-specific nature of risk propensity, we elected to adapt the CDQ to an IS project context.

Using the basic structure of the CDQ, five information systems scenarios were developed in which the subjects were asked to indicate the probability of success that they would require before selecting the riskier of two courses of action. One of the five scenarios is displayed in Appendix B as an example. Each scenario was based on a different dimension of IS project risk as described by Barki et al. (1993). The five CDQ-based propensity measures resulted in a Cronbach’s alpha of 0.65. The five items were therefore combined (again, using a simple average) to create an aggregate measure of risk propensity.

The decision of whether or not to continue with the project was measured using a single Likert-type scale item designed to capture the likelihood of continuing with the project (1 = Very Likely to Continue; 7 = Very Likely to Discontinue). The reliability of this measure is not known due to the use of a single scale item.

5. Results

As a manipulation check, subjects were asked to respond to a series of four Likert-type questions designed to measure their perceptions of the probability of failure and the magnitude of potential loss. Based on a reliability analysis, two of these items were combined to form an aggregate measure of perceived probability of failure and the other two items were combined to form an aggregate measure of perceived magnitude of potential loss. Analysis of variance (ANOVA) revealed that subjects were responding to the treatments as anticipated. That is, subjects that were manipulated to believe that the probability of failure was high (n = 77) perceived it to be high (a mean of 4.53 on a 7-point scale), while subjects in the low (n = 77) manipulation perceived it to be low (a mean of 3.16). A Scheffe test with a 0.05 significance level revealed that these differences were significant.

A similar ANOVA revealed that subjects that were manipulated to believe that the magnitude of potential loss was high (n = 84) perceived it to be high (a mean of 4.56 on a 7-point scale), while subjects in the low manipulation groups (n = 76) perceived it to be low (a mean of 2.58). The range of perceptions recorded on the two variables of interest was comparable, suggesting that the perceptions of what constituted low vs. high was similar for the two manipulated variables despite differences in how they were manipulated.

The results of the four hypothesis tests are explained below and a summary of the findings is shown in Fig. 4.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Supported?</th>
</tr>
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<tbody>
<tr>
<td>H1: Magnitude of potential loss will have a greater impact on risk perception than will the probability of a loss occurring</td>
<td>Yes</td>
</tr>
<tr>
<td>H2.1: There will be a significant negative relationship between risk perception and the decision to continue a software development project.</td>
<td>Yes</td>
</tr>
<tr>
<td>H2.2: There will be a significant positive relationship between risk propensity and the decision to continue a software development project.</td>
<td>No</td>
</tr>
<tr>
<td>H2.3: There will be a significant negative relationship between risk propensity and risk perception</td>
<td>No</td>
</tr>
</tbody>
</table>

Fig. 4. Hypothesis testing results.
5.1. Hypothesis 1

A two-way factorial design ANOVA was performed to examine the effect of magnitude of potential loss and probability of failure on risk perception. As indicated in Fig. 5, main effects were observed only for the magnitude of potential loss variable and no interaction effects were detected. This result is consistent with the observation made by March and Shapira (1987) that managers find the magnitude, rather than the probability, of a potential loss to be the more salient dimension of risk.

In parallel with the quantitative analysis, we used content analysis both as a means of triangulation and to gain additional insight into the factors that shape risk perception. The content analysis focused on the written explanations that subjects provided in defence of their decision to continue or discontinue the project described in the scenario. After preparing the handwritten texts for content analysis, two of the authors worked together to analyze each subject’s response. Unique codes were created to capture the various factors that subjects indicated to be influential in their decision to continue or discontinue the project. Two content variables (codes) were created at the outset; one for reasons relating to the probability of failure and one for reasons relating to the magnitude of potential loss. For the purposes of this analysis, the probability of failure code was applied whenever a subject referred to the likelihood of project success or failure. The magnitude of potential loss code was applied whenever a subject referred to the potential impact that a project failure would have on the company. Other codes were created as needed in order to capture other factors that subjects said they considered in reaching a decision. A total of 233 usable responses were coded in this manner.

Consistent with the experimental manipulation, magnitude of potential loss and probability of failure emerged as the two most frequently mentioned factors viewed as influential in the decision to continue or discontinue the project. Ninety-eight subjects (42 percent) made reference to the magnitude of potential loss as an important factor in their decision, while only 54 subjects (23 percent) mentioned the probability of failure as being an important factor.

Among those who mentioned the magnitude of potential loss, the following remarks were typical:

“With a high magnitude of potential loss, this project if it should fail, would virtually destroy the company.”

“With the magnitude of potential loss being high I don’t feel it is in the company’s best interest to take the chance...”

Although mentioned nearly half as often as magnitude of potential loss, the probability of failure was also observed as an influential factor. The following remarks were typical:

“A one-in-four probability of success is simply not enough to justify continuance of the project.”

“I would be more likely to continue with a higher chance of success.”

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
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<tbody>
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<td>Main Effects</td>
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<tr>
<td>MAGNITUDE</td>
<td>14.919</td>
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<tr>
<td>PROBABILITY</td>
<td>0.530</td>
<td>.589</td>
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<tr>
<td>Interaction</td>
<td>MAGNITUDE PROBABILITY</td>
<td>.761</td>
</tr>
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</table>

R2a squared=.132
242 cases were processed. 8 cases (3.3 %) were missing

Fig. 5. Two-way ANOVA for risk perception.
While both factors were clearly seen to be influential in the decision-making process, the results of the content analysis provide further evidence that the magnitude of potential loss plays a more significant role than does the probability of failure.

5.2. Hypotheses 2.1, 2.2, and 2.3

In order to test H2.1 and H2.2 a stepwise regression was performed to see which of the variables (risk perception, risk propensity) best explained the variance in decision-making. The results of the regression indicate that risk perception has a strong negative influence on the decision to continue (Adj. $R^2 = 0.268$, $F = 84.67$, $P < 0.0001$). Risk propensity, however, did not explain a significant amount of the variance in decision-making and did not enter into the regression. These results imply that while risk perception is highly correlated with decision-making, an individual’s risk propensity (at least as measured in this experiment) does not appear to have much impact on decision-making. These findings are consistent with those reported from a similar study conducted by Sitkin and Weingart (1995). Using an original five-item scale for business risk propensity, Sitkin and Weingart (1995) found no significant direct effect of risk propensity on decision-making.

H2.3 was tested with a regression of risk propensity on risk perception. The regression results showed no significant effect. This finding runs counter to results reported by Sitkin and Weingart (1995) and suggests the need for further study of the relationship between risk propensity and risk perception.

6. Discussion and conclusions

Before discussing the key findings of this study, it is appropriate to consider the study’s limitations. As with all laboratory experiments, there are limitations concerning generalizability. While we believe that students are appropriate subjects for experiments involving human decision-making under uncertainty, it should be noted that student subjects may have different criteria for judging the risk associated with business opportunities than those that would be exhibited by practicing managers. The results should therefore be interpreted with caution until the study is found to be replicable with practicing IS managers as subjects.

It should also be noted that there are many factors in an organizational setting that may influence decision-making but which were not modeled here. Examples include organizational politics, the presence or absence of competing projects, and so forth. In addition, those variables that were manipulated may have been assigned values that are not characteristic of “average” or typical IS projects. For example, projects that threaten a company’s survival (which was part of our operationalization of “high” magnitude of potential loss) may occur rather infrequently. The manipulations chosen for this experiment were designed to maximize our “signal to noise” ratio in testing the relationships among the constructs specified in our model. We make no claim here that they generalize to typical project decisions. Finally, it should be noted that our probability of failure manipulation was numeric while our magnitude of potential loss manipulation was non-numeric. While it is possible that this may have created certain biases in how the subjects responded to the treatments, we do not believe that it poses a significant threat to the design of the experiment or the interpretation of the results. As noted earlier, our manipulation checks clearly show that the range of perceptions recorded on the two variables of interest was comparable, suggesting that the perceptions of what constituted low vs. high were similar for the two manipulated variables despite differences in how they were manipulated.

Inspite of the above limitations, we believe that there are two key findings that emerge from this study: (1) an individual’s risk perception appears to be shaped more by perceived downside potential than the actual probability of failure occurring, and (2) an individual’s willingness to pursue a risky project appears to be influenced more by risk perception than by any innate propensity to take or avoid risks.

The first contribution of this study is that it provides strong empirical evidence in support of March and Shapira’s (1987) observation that managers’ risk perceptions appear to be based more on the magnitude of potential loss as opposed to the probability that a loss will occur. The implication of this finding is significant to both IS academics and practitioners because it suggests that interventions designed to heighten risk perception should highlight the downside potential of a project. It is interesting to note that existing risk checklists and surveys (e.g., Boehm and Ross, 1989; Barki et al., 1993) primarily emphasize elements that contribute to the probability of project failure rather than the magnitude of loss should a failure occur. Extrapolating from our findings, however, we believe that risk assessment instruments will be most effective when they force managers to confront the magnitude of the potential loss associated with a course of action, rather than simply highlighting the elements that could contribute to the possibility of a failure.

The second key finding that emerges from this study is that risk perception appears to have a much more significant influence on decision-making than does risk propensity. This result, consistent with a recent study reported by Sitkin
and Weingart (1995), is significant because it implies that decision-making can be modified through manipulation of risk perception, in spite of any individual differences that may exist in terms of risk propensity. Thus, it may be possible to design risk assessment instruments and other interventions that reduce the incidence of project failure by altering managers’ risk perceptions.

The results of this study therefore represent an important first step in determining whether risk assessment devices can serve as an effective means of reducing the incidence of IS project failures. A clear link between risk perception and decision-making has been established and the results of the study show that perception is a more important determinant than risk propensity. Having established this link, one obvious direction for future research would be to determine what effect, if any, the existing risk assessment devices actually have on managers’ risk perception. If such devices can be shown to affect managers’ risk perceptions, then perhaps they can be used to help managers avoid unnecessary IS development risks and to develop strategies for dealing with risks that are unavoidable.

Risk assessment devices may be able to aid managers by heightening their perception of the risks associated with systems development projects. Such devices could also help by allowing managers to identify specific risk areas. Once specific risks have been identified managers may then take the necessary steps to control them. Clearly, however, the relationships between risk assessment, risk perception, and decision-making must be studied further before any firm conclusions can be drawn about the effectiveness of this approach.

Another avenue for future research would be to explore the relationships that exist between various risk factors associated with IS projects and the extent to which these factors influence risk perception. McFarlan (1981) has identified three dimensions of IS project risk and Barki et al. (1993) have developed a broader set of dimensions based on their review of the literature. Using these and perhaps other characterizations of the dimensions of IS project risk, it should be possible to begin exploring how each of these factors individually and collectively affect risk perception.

Appendix A. Scenario: Computer Diagnostics Corporation

You are a software project manager for Computer Diagnostics Corporation, a computer software company. You are currently reviewing the progress of a development team that is working on a project called COMPULERT which involves the development of an artificial intelligence system for monitoring, diagnosing, and reporting computer hardware problems before they become serious. If successful, this software product should appeal to all the major computer companies in the US, which are under increasing pressure to improve the level of service provided to their customers.

COMPULERT has been underway for two years, and is now undergoing a standard periodic review of the project’s progress. This standard review includes a risk assessment of the project, evaluating such dimensions as technological newness, application size and complexity, project team expertise, and magnitude of potential loss. Much of the information in the risk assessment is based on progress reports from members of COMPULERT’s development team and data from your company’s marketing and sales departments, indicating the market potential for the product. This risk assessment has been compiled by a specialist from Computer Diagnostics’ risk management department.

At the end of the risk assessment document, there is a final rating consisting of two components. The first component is called “PROBABILITY OF FAILURE.” In this case, failure means that sales of the product will not produce enough money to offset the costs of development. In other words, the project will negatively impact profits. This could occur for a variety of reasons: the software project may be difficult to complete, costs of the project could exceed the budget by a substantial amount, or the software may show little or no sales. In other words, failure could occur at any stage of the project. The risk assessment does not distinguish between the various causes of failure, but merely assesses the overall probability of failure as defined above.

The second component of the risk rating is called “MAGNITUDE OF POTENTIAL LOSS” and is the level of loss that the company will experience if the software project “fails.” This component is given the rating of LOW, MEDIUM, or HIGH. These are defined as:

- **LOW:** The failure of this project will have little or no effect on the company’s financial position or ability to survive.

- **MEDIUM:** The failure of this project will have a significant effect on the company’s financial position, but not on the company’s ability to survive.

- **HIGH:** The failure of this project will have a significant effect on the company’s financial position and will threaten the company’s ability to survive.

Computer Diagnostics believes that both components, PROBABILITY OF FAILURE and MAGNITUDE OF POTENTIAL LOSS, are critical in properly assessing the riskiness of software projects.
The risk assessment for the COMPULERT project consisted of the following ratings:

PROBABILITY OF FAILURE 75%
MAGNITUDE OF POTENTIAL LOSS HIGH

As the project reviewer for COMPULERT, you are now faced with the decision of whether to recommend that the COMPULERT project be continued or discontinued.

Appendix B. Risk perception and risk propensity measures

The following two items used to measure risk perception were developed by the authors for use in this study.

| I believe that the overall riskiness of the COMPULERT project is very high. | Strongly disagree | Neutral or unsure | Strongly agree |
| I believe that the overall riskiness of the COMPULERT project is very low. | ☐ | ☐ | ☐ |

The following item represents one of the six scenario-based measures for assessing risk propensity in an IS project context. The structure of the scenario and the measure is based on the choice dilemma questionnaire (Kogan and Wallach 1964).

Mr. S. is the president of a small software company that develops information systems for local and regional banks. Recently, his largest customer – a major banking company – has asked him to develop a communications program that would allow customers to pay bills, check account balances, apply for loans, and perform other services from home. This would be a windows-based product designed to run on PCs. Mr. S’s development team has no prior experience in developing windows-based applications.

Mr. S. knows that his team will eventually have to gain expertise in developing windows-based applications, but he is hesitant about committing to such a project when his developers lack experience in this area. If he turns down the project, the short-term implications would be slight, though negative. If he accepts the project and it is successful, this customer would almost certainly send more projects his way, and his company could adapt the software for other banks, thereby increasing revenues substantially. However, if the project fails, then Mr. S. believes that the bank will blame his company and he will lose his biggest customer.

Imagine that you are advising Mr. S. Listed below are several probabilities or odds that the windows-based project would be successful. Please check the lowest probability that you would consider acceptable for Mr. S. to accept the windows-based project.

——— The chances are 1 in 10 that the windows-based project would be successful.
——— The chances are 3 in 10 that the windows-based project would be successful.
——— The chances are 5 in 10 that the windows-based project would be successful.
——— The chances are 7 in 10 that the windows-based project would be successful.
——— The chances are 9 in 10 that the windows-based project would be successful.
——— Mr. S. should not attempt to complete the window-based project, no matter what the probabilities.

Note: Five additional scenarios identical in format to the one above were created, each based on a different dimension of IS project risk as described by Barki et al. (1993).

References


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