

Contractor's Risk Attitudes in the Selection of International Construction Projects

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Abstract: International construction involves all of the uncertainties common to domestic construction projects as well as risks specific to international transactions. Consequently, despite the worldwide trend toward globalization, a very small portion of contractors actively seek international contracts due to concerns of probable failures. This paper describes findings from experiments done to investigate the risk attitude and bid decision behavior in the selection of international projects. The participants demonstrated either weak risk seeking in profit situations or strong risk seeking toward loss situations when choosing between conflicting options of risky opportunities and sure payoffs. On the other hand, another experimental test attempting to investigate bid behavior when making a realistic bid or no-bid decision in a complicated international construction project reveals the prevailing risk aversion. Further, this paper finds the experimental supports for some of the errors and biases due to risk attitude that commonly exist in bid decisions in this area. Finally, we present lessons learned and guidelines to make a qualified bid decision through feedback with the participants.

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Introduction

Globalization pressures have created more opportunities for contractors to enter international construction markets. According to Han (1999), the potential international construction markets are valued at approximately \$3.4 trillion. At present, only 3.4% of this potential volume (\$116 billion) is actually open to a fully international competitive market and being done by multinational foreign firms. Accordingly, the globalization of international construction markets will provide tremendous opportunities for contractors to expand into new foreign markets by allowing local firms to compete internationally.

However, bid decisions for international construction markets are difficult due to the uncertainties and complexities associated with the international construction domain. Failure to understand these risky conditions—such as political, economic, cultural, and legal project conditions—can significantly affect a firm's strategic goals associated with a new foreign market. For example, according to Engineering News Record (Engineering News Record 1994–2002), almost 15.1% of companies among the “top 225

global contractors” have sustained losses on their international markets, while only 9.7% of them have suffered losses in domestic projects. More significantly, the average profit from foreign works among these contractors has declined significantly during the last 5 years around 2.6 to 7.2%. It implies that the international construction market involves higher risk, but cannot always secure higher returns for the effort.

Perhaps, this explains why, in contrast to the globalization trend, only 19% of current “Top 400 U.S. Contractors” actively seek and conduct international contracts (Engineering News Record 2002). It implies that construction firms are apt to display severe risk aversion that can bias reliable and consistent bid decisions in threat or opportunity situations. The fundamental goal of this paper is to test risk attitudes in making a complex bid decision in the international business environment. We conducted two procedural experimental tests to investigate risk attitudes. The initial experiment is designed to test an individual's risk attitude in: (1) Choosing between risky opportunity and sure payoff in the case of both gain and loss, and (2) rating preferences among different projects with different risk profiles involving the trade-off between expected value and variation. The subsequent test is performed to investigate bid behavior when making a realistic bid or no-bid decision in complicated international construction projects. In order to achieve this goal, this paper focuses on the following hypothetical questions in the specific domain of international construction environments:

1. Do decision makers display different risk attitude toward “loss and gain” and “different risk-return profiles?”
2. Do decision makers basically take on risk averse in making realistic bid decisions?
3. Does a decision makers' basic risk attitude influence the actual bid decisions?
4. Can bid decisions vary with respect to the project conditions (good, moderate, and bad), personal experience (domain-

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specific industry experts and novices), decision tools (intuitive judgment and decision support model), and the decision makers' nationalities (North Americans and Koreans)?

Characteristics of Global Expansion

Numerous authors (Lucas 1986; Ashley and Bonner 1987; Aziz 1992) have identified the motive for global expansion. Most countries seek to obtain contracts overseas to increase their volume of foreign construction. At the national level, the volume of international contracts contributes to a nation's trade balance. In addition, they seek to balance the growth of their company to contribute to their security through increased global activities and so to mitigate the impact of the cyclic nature of their workload. Moreover, highly specialized firms view work abroad as a means of capitalizing on expertise and experience gained from long involvement in one type of construction or technology.

However, despite these strong motives, a relatively small number of contractors are participating in the international construction market. It is mainly because international construction contains higher risk than that of domestic markets. The variety of these risks make decision makers more averse to international construction projects and force them to require more return before making a bid decision. As a consequence, contractors are less self-assured regarding their bid decisions for international project than for doing work in domestic markets.

In particular, small- and medium-sized firms are less likely to enter culturally distant markets because environmental uncertainty makes them shy away from new investments or opportunities and minimize their resource commitments (Lynn and Reinsch 1990; Krishma et al. 1993). These firms are forced to seek low-risk low-growth alternatives and generally lack the financial capability to provide margin and contingency of error. This is highly likely to be the case that contractors that ranked between 100 and 400 among the Top 400 U.S. Contractors rarely participate in international construction markets. In addition, international construction projects are typically larger in size and more complex technologically and organizationally. Due to the distribution of projects around world, the international contractor is more project oriented, more mobile, and subject to more environmental influences.

This risky nature of international construction makes the bid decision for potential project opportunities difficult and severely hampers a firm's success. In the critical review of international manufacturing business failure done by Gordon and Arnold (1988) and White (1990), a number of important reasons why international businesses fail were pointed out: (1) Failure to develop a business plan; (2) lack of commitment from top management in the early stages of the venture; (3) lack of attention to the development of strategic links in the international market place; (4) failure to recognize the demands of operating in a multicultural business environment; and (5) failure to weigh foreign requirements with respect to their social, legal, political, and governmental procedures.

Specifically, Lee and Walters (1989) investigated the various tariff and nontariff barriers to international construction transactions which put foreign construction firms at a competitive disadvantage and potential failures in doing business in international construction. Moreover, surveys done by U.S. International Trade Administration (1989) and International Contractors Association of Korea (2002) show the case studies of damages/losses in international construction projects.

As presented, typical causes of failure in international construction projects mainly result from various trade barriers—related to government procurement, subsidies, license, and certification requirements—and project-specific losses, such as repudiation, low bid price, labor issues, etc. Consequently, any possible combinations of these failure factors can make international construction quite risky and these causes of business failure can seriously affect decision makers' project selections.

Previous Studies Related to Risk Attitudes

Many authors have emphasized the importance of recognizing decision-makers' risk attitude in decision making. According to prospect theory (Kahnemann and Tversky 1979, 1982), the subjective values to the outcome (analogous to utility curves) for gains and losses are nonlinear, so-called normally concave for gains and convex for losses. It means that decision makers are more risk averse in the domain of gains and risk seeking in the domain of losses. In addition, the authors offered support to justify the forms of prospect theory's value: (1) Decision makers segregate gains and integrate losses to maximize satisfaction; (2) gains increase more slowly than losses decrease ("loss aversion"—a loss of a certain number of dollars is more aversive than a gain of the same amount is attractive); and (3) people are often risk averse in dealing with a small chance of a severe loss and risk seeking in dealing with improbable gains. This loss aversion has been offered as an explanation of why people categorize outcomes as gains or losses and dislike losses more than they like equivalent gains.

MacCrimmon and Wehrung (1986) conducted risk attitude surveys in various business contexts. This study revealed important facts regarding a decision maker's attitude: (1) Decision makers are more risk averse in opportunity situations than in threat situations; (2) decision makers are extremely risk averse when the chance of loss is too high; (3) both Canadian and American managers believe that Canadians are more risk averse, but there was no significant evidence to support this belief; and (4) generally, older decision makers with more seniority in their firms are more risk averse. The results of this study are basically very analogous to the works of Kahnemann and Tversky. Both studies show that decision makers are inherently risk averse in gain (opportunity situation) and risk seeking in loss (threat situation).

In particular, Taylor (1991) concluded that subjects are more motivated to avoid losses than to obtain the equivalent gains. Brown (1995) also demonstrated that individuals gain knowledge of forecasting with greater accuracy when threatened by a loss than motivated with more gains (referred to as "loss avoidance"). In addition to these studies, Mak and Raftery (1992) demonstrated that people tended to be risk averse in forecasting project return ("conservative") and to be risk seeking in estimating project cost ("speculative"), which leads to the differences in personal risk perceptions and also generates the systematic biases in forecasting both project cost and return. Moreover, they indicated that professional individuals trained in a specific domain tended to be less error prone in making estimations than is the case of a novice group.

In comparison to these studies, a number of researchers have attempted to find risk attitudes in business decision making and human judgment. According to Cohen et al. (1982), men are generally less risk averse than women and so are people with higher levels of income. Weber and Hsee (1998) indicated a cultural impact on risk attitudes demonstrating that the Chinese are more

risk averse than Americans or Poles. In particular, de Neufville et al. (1977) indicated that contractors behave differently when dealing with small and large projects, and when operating in good years or bad so that they are most risk averse toward larger projects in lean years and bid relatively lower.

All of the studies mentioned above reveal that risk behavior plays a central role in humans' decision making under uncertainty. Not surprisingly, however, previous research has mostly focused on how the risk attitude of decision makers can vary under assumed risk situations represented by simple lotteries. Consequently, they cannot forecast risk attitudes under realistic decision making situations such as bid/no-bid decision for international projects which exhibit a complex skein of various uncertainties. This paper is concerned with experimental testing for the risk attitude of project selections in a specific domain of more realistic international construction environments.

Risk Attitude Test: Step 1

Participants

The participants consist of two groups. Novice subjects were selected from the graduate students enrolled in risk and decision analysis classes at the University of Colorado and Yonsei University in Korea. In an attempt to find industry participants, a letter was mailed to both the top 100 North American and top 100 Korean contractors. Several techniques—such as a reminder letter, phone calls, and requests for a substitute—were devised to increase the participation rate. Ultimately, 44 graduate students from 2 universities, and 47 industry practitioners from 31 companies (21 from North American and 10 from Korean contractors) were willing to participate in the experiment—representing a 23% response rate. Apparently, it is noted that various sources of participants can avoid bring out similar opinion from a few companies. Of the 47 industry participants, almost all of them (around 90%) were from the vice president, director, or manager level who have backgrounds with experience in both domestic and international projects. Of the 91 total participants, 50 were from North America (24 from graduate students, 26 from industry) and 41 were from Korea (20 from graduate students, 21 from industry).

As explained, this research consists of two-step experiments; subsequently it requires the respondents of significant efforts and abilities to comprehend the time-consuming and complex experiment procedures. As the respondents were selected from different ethnic groups and with experience in overseas construction projects, there might be differences in their abilities to comprehend the long questionnaires and complex project information. To improve the reliability of the respondents, the subjects from graduate schools were provided with the generic procedures and characteristics of international projects through graduate course work. Also, the industry participants were considered similar to each other in their abilities because they have experienced real overseas projects mostly as a program manager or a chief estimator to evaluate the feasibility of diverse international projects for a number of years. Further, we explained the basic guidelines as a means of supporting each participant to understand the characteristics of international projects and the stepwise voluminous questionnaires through the predestined website (<http://www.colorado.edu/engineering/civil/cem/Risks/>).

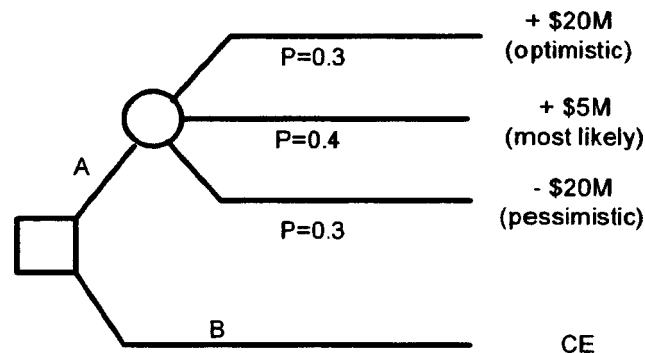


Fig. 1. Reference investment to measure subjects' risk attitude (in the profit case)

Test Methods and Results

Different people have different attitudes toward risk, and thus make different choices within the same risky context. A formal approach to reflecting the risk attitudes in decision making uses utility theory. Clearly, risk attitude is represented by the convexity or concavity of an individual's utility function when faced with the choice between an uncertain payoff and a safe bet. One way to assess the convexity or concavity of this function is to find the point at which the participant is indifferent between the safe and risky options (Brown and Stewart 1999).

This research measures the subjects' risk attitude as a part of the test to examine if it could influence the bid decision-making process. Two methods are available to assess the utility functions: (1) Certainty equivalent (CE) and (2) probability equivalent (PE) methods. While the former requires decision makers to assess several sure payoffs (i.e., CEs) that are equivalent in their mind to a given situation involving uncertainty, the latter needs them to adjust the probability to achieve indifference in the payoffs. While several researchers have doubted the usefulness of CE or PE as a meaningful indicator of an individual risk attitude (Krahen et al. 1997), this study adopts the CE assessment technique to measure the subjects' risk attitudes because it is widely accepted and easily used for common participants. With the reference lottery in Fig. 1, the subjects are asked to specify how much sure payoff must be received to make them indifferent between the sure payoff (CE) and the expected value of the given risky investment that is not certain.

In most other studies, subjects were simply asked to represent the CE for given lotteries to determine their attitude toward risk. This paper, however, is based on the experimentation where subjects are ensured by accepting or refusing different monetary values being offered. To reflect the international business situation, these investment options were based on international projects of which endpoint values are in millions (M) of U.S. dollars. Typical risk situations can be formulated by combining the magnitude of probabilities and the magnitude of gain or loss. This paper tests the decision maker's risk attitude in a typical situation of international project selection, that is, generally with a relatively "big probability of significant gain and significant loss" (see Fig. 1).

To determine their risk attitude, the subjects were asked to put themselves in the central decision making role in the given situation. For a risk-aversion person, CE value would be less than the expected monetary value (EMV) [$EMV = \$20M \times 0.3 + \$5M \times 0.4 - \$20M \times 0.3 = \$2M$] because he/she is indifferent between lower CE and the risky investment and so the utility of CE must equal the higher expected utility of the risky investment. For ex-

Table 1. Test Results of Subjects' Risk Attitude

Case	Items	Percent of subjects answered (%)			Average minimum CE
		To accept	To refuse	To be indifferent	
In profit	Offered CE=\$1M	22.2%	77.8%	—	\$2.47M (Risk seeking dominant)
	Offered CE=\$2M ^a	44.4%	52.4%	3.2%	
	Offered CE=\$3M	82.5%	17.5%	—	
In loss	Offered CE=\$3M	4.8%	95.2%	—	-\$1.46M (Risk seeking dominant)
	Offered CE=-\$2M ^a	30.2%	63.5%	6.3%	
	Offered CE=-\$1M	84.1%	12.7%	3.2%	

Note: CE=certainty equivalent.

^aThe expected monetary value for the risky option.

ample, if someone answers CE equals \$1M, it indicates that he/she prefers the sure payoffs rather than risky options. On the other hand, if the CE was greater than the EMV, this would imply that the decision maker would be a risk seeker who is not content to release the risky opportunity without being paid. To define the subjects' prevailing risk attitude, three typical CE to differentiate the personal risk propensity are offered to each subject and he/she is asked to accept (yes) or refuse (no) the offered CE (see Appendix I). In addition, each subject is required to measure the minimum CE which makes him or her prefer a sure outcome over a risky option.

The subjects who answered "yes" or "indifferent" to the CE which is less than or equal to the EMV are considered risk averse. Conversely, the subjects who answered "no" to the CE which is less than or equal to the EMV are considered risk seeking. Table 1 shows the test results indicating that decision makers in the profit situation assume weak risk seeking because half and more subjects would not like to sell the risky opportunity when they were paid the CE that is less than or equal to the EMV. The critical factors which effected their decisions are summarized sequentially as: (1) Expected return; (2) chance of gain; (3) the highest potential amount of gain (significant gain); (4) the highest potential amount of loss (significant loss); and (5) chance of loss. These factors can be explained by the fact that the decision makers are willing to invest in risky situations, particularly in the specific domain of a "big probability of significant gain and significant loss" configuration. Accordingly, they focused on the speculative factors such as probability of gain and amount of gain despite the project having a 30% potential for significant loss. These factors motivated decision makers to invest in the risky situation.

Similarly, in another case when the investment lottery was revised to lose money by changing the most likely tree as (-) \$5.M ($EMV = \$20M \times 0.3 - \$5M \times 0.4 - \$20M \times 0.3 = -\$2M$), most subjects showed strong risk seeking attitudes. This implies that they prefer risky investments to the sure loss and, consequently, focused on the positive factors such as potential probability and amount of gain rather than possibility of loss. These findings are slightly inconsistent with previous studies in that decision makers are likely to be more risk seeking both in gain and loss situations. Approximately two-thirds of the subjects in the profit situation appeared risk seeking when focusing on possible gain rather than risk averse when attempting to avoid the severe loss by capturing the CE—somewhat contrary to previous research. It is mainly because we formulated this test to include significant loss, nominal gain, and significant gain, which exhibits a complex combination of decision situations. Subsequently, risk attitudes

toward gain were slightly dissimilar compared to the test results performed in a simple teasing lottery test (i.e., an optimistic gamble which consists of small chances of big gain, and a big chance of gaining nothing). For example, according to test results of Kahnemann and Tversky (1982), 84% of subjects preferred the sure gain (\$240) to the gamble that consists of 25% chance of gaining \$1,000 and 75% chance of gaining nothing, which forced them to avoid the higher possibility of bad consequences. However, our study reveals that the majority of participants who took on risk seeking attitudes in the profit situation were motivated to prefer a risky option because it involves a big probability of big gain (in the sense that the probability of gain and their payoff are 70% and \$8M, respectively).

The above tests were performed to determine the basic risk attitude in choosing between the conflicting options of risky opportunity and sure payoff. However, when people make a decision between two alternatives, generally both alternatives are perceived as risky. While some people prefer safer options, others assume risks in exchange for a chance of return. A number of researchers (An and Tang 1984; Moselhi and Deb 1993) have noted that the expected utility for project selection with a consideration of risk can be expressed by the mean value and the standard deviation of the possible outcome. Accordingly, the possible trade-off between expected value and variation among different international projects could be an interesting area to survey. To evaluate the risk-return preference, we conducted another test which asked participants to rank the preferred options among three alternatives with different risk profiles by using index numbers ranging from 1 (least preferable) to 7 (most preferable). Table 2 summarizes the test results.

It is noted that the participants may decide that they are willing to accept a \$3.5M increase (100%) of the expected return for the \$13.6M increase (230%) in variation between Option 1 and Option 2. However, unlike the above choice, they preferred Option 2 over Option 3 despite Option 3 having the highest expected return. The fact that the highly risky situation involved in Option 3 cannot be compensated for by an improvement on the expected return explains this result. In addition, each subject was required to rank the factors which affected his/her preference. The critical factors are summarized sequentially as: (1) Expected return; (2) the highest potential amount of loss (significant loss); (3) the highest potential amount of gain (significant gain); (4) variations in return (standard deviation); and (5) chance of gain. The important point to note is that the subjects preferred a higher expected return to some extent, but concurrently they did not prefer higher variation in return in choosing between competing projects.

Specifically, the means of the minimum CE and preferences

Table 2. Test Results of Risk–Return Rating (Unit: \$Million)

Option	Items	Risk profiles				Average preference index ^a	Average ranking (1–3)
		Possible outcomes	Probability	Expected return	Standard deviation		
1	Pessimistic (loss)	–5	0.3	3.5	5.9	4.38	1.81
	Most likely	5	0.4				
	Optimistic (gain)	10	0.3				
2	Pessimistic (loss)	–20	0.3	7	19.5	4.59	1.62
	Most likely	10	0.4				
	Optimistic (gain)	30	0.3				
3	Pessimistic (loss)	–50	0.3	12	46.5	3.17	2.57
	Most likely	15	0.4				
	Optimistic (gain)	70	0.3				

^aNote: 1: Least preferable, 7: Most preferable

among three risk-return options between the two groups (novice and industry) are compared. The independent-samples t-test was performed to analyze the data between these groups. The null hypothesis is that there is no difference between groups in terms of subjects' risk attitude and their preferences among different risk-return traded projects. Table 3 shows that with the degree of freedom of 89, the observed difference of 1.7 for the means of subject's preference to Option 1 (safest) differed significantly at 5% significant level ($p < 0.05$, two-tailed test). This indicates that a preference level to Option 1 of industry participants is higher than that of the novice group. In contrast with the novice group, industry participants showed more conservative attitudes toward their selection and subsequently preferred the safest Option 1 to riskier Option 2. For other items, we found no statistically significant differences at the level of 0.05.

Experiment to Test Bid Behavior: Step 2

Experiment Design

We performed the previous tests to determine the basic personal risk attitude in choosing between the conflicting options of a risky opportunity and sure payoff. The participants showed weak risk seeking in profit situations and strong risk seeking in loss situations. However, decision makers seldom confront such opportunities that offer a completely sure payoff in the real business

Table 3. Independent-Samples T-Test Results (between Novice and Industry)

Items	Mean		t values	p (two tailed)
	Novice	Industry		
Minimum CE (Profit case)	\$2.54M	\$2.40M	0.495	0.623
Minimum CE (Loss case)	–\$1.32M	–\$1.62M	1.011	0.316
Preference to Option 1	3.70	5.13	4.840	0.000
Preference to Option 2	4.60	4.56	0.144	0.886
Preference to Option 3	3.18	3.17	0.040	0.968

Note: CE=Certainty equivalent. Bold-faced items indicate significant differences at 95% confidence level.

environment. Accordingly, we have moved from the test of subjects' basic risk attitude to the experimental test to investigate bid behavior when making a bid decision on complicated international construction projects.

An experimental test was conducted to identify the risk attitude on realistic international project selections rather than evaluating CE to determine risk propensity. In this test, the risk attitude is a function of independent variables such as intuition or the decision support model, decision makers' international experience, decision makers' nationalities, and various configurations of project conditions.

The participants consisted of two different backgrounds with regard to experience (44 novice graduate students, 47 industry professionals). These two groups were divided equally into two subgroups, which consisted of an "intuition group" and "decision support model group." As indicated by the subgroup names, the intuition group used their intuition combined with rudimentary financial analysis to make the bid decision. The model group used the decision support model to make bid decisions proposed in the following section. Participants were randomly selected and exposed to only one level of test.

One of three international projects was assigned randomly and equally to each participant in an attempt to investigate the risk attitude according to the project conditions and participants' experience. These case projects were prepared based on three real overseas projects, such as a power plant (Case 1), housing project (Case 2), and highway project (Case 3). We modified the real project conditions to shape diverse project conditions (e.g., good, moderate, or bad) in an attempt to measure the risk attitudes in deciding a bid decision in the event of specific project conditions. The modifications include manipulating project economic situations as well as assigning the critical success/failure factors to each case based on the previous research, such as Arditi and Gutierrez (1991), Kalayjian (2000), and Han and Diekmann (2001). In addition, five other industry experts were joined for prior assessment of each project with a consideration of both their own judgments and the computational results from the decision support tool proposed (see the following section). Accordingly, through the manipulations, a consensus of prior experts' assessment, and support from the decision analysis tool, the Case 3 project is assessed to be a "good" candidate; the Case 1 project is a "moderate" candidate; and the Case 2 project is a "bad" candidate.

The suggested correct decisions were veiled from all participants in order to avoid any potential biases. The subjects were

Table 4. Test Results of Subjects' Bid Decision

		Number of subjects answered (91 subjects)				
		Novice subjects		Industry subjects		
Case	Items	Intuition	Model assisted	Intuition	Model assisted	Total
1 (Moderate)	Bid	5	0	2	0	7
	No bid	2	6	5	4	17
	Inter mediate	0	2	1	3	6
	Subtotal	7	8	8	7	30
2 (Bad)	Bid	1	0	0	0	1
	No bid	5	7	8	8	28
	Intermediate	1	0	0	0	1
	Subtotal	7	7	8	8	30
3 (Good)	Bid	7	6	4	6	23
	No bid	1	0	4	1	6
	Intermediate	0	1	0	1	2
	Subtotal	8	7	8	8	31
Total		22	22	24	23	91

Note: Bold-faced decisions indicate the correct answers suggested. Participants were randomly selected and exposed to only one level of test. Therefore, once the participants' backgrounds (novice or industry professional) were identified, each participant within each group was randomly and equally assigned to the two subgroups ("Intuition" or "Model assisted"). Finally, one of three international projects were assigned randomly and equally to each participant.

given information describing the detailed conditions of the project and were not told which group they were in. The test was limited to a single decision making unit, while real decision situations typically consist of multiple decision participants who exhibit different types of decision behaviors. However, the selection of a single respondent from each firm is justified because we asked participants to make a decision from the firm's standpoint. Examples of the information and the questionnaires are shown in Appendix II.

Apart from the typical format of experimentation, this test was not performed in a laboratory environment because a bid decision under various risk configurations requires sufficient time. Therefore, participants were not forced to complete the questionnaires hurriedly (in general, we asked them to finish it in less than 2 h).

Formalizing a Decision Support Tool

To discover the risk attitude in intuition-based and model-assisted bid decisions associated with overseas projects, we proposed the formal decision support model. The decision support model is conceptualized as one that is decided primarily on a profit criterion. If a project fails to satisfy the profitability criterion, other potential benefits of pursuing the project are considered. In this process, the decision maker sets an absolute goal on "project profitability" above which the decision is "definitely go." The decision maker also sets a lower profitability limit to fix the "definitely no-go" decision. If project profitability lies between the profitability limits, the decision is made based on multicriteria considering both "project profitability" and "other project benefits such as gaining future markets, their need for work, developing new relationships, etc." In addition, this model applies the cross impact analysis (CIA) method to assess the various uncertainties associated with international construction.

The model generates the two outcome criteria from the CIA calculation: (1) Project profitability and (2) other project benefits. The decision maker can make a bid/no-bid decision by determin-

ing definite go and definite no-go percent of profitability, by assigning "weight" to these multicriteria outcomes, and by setting up a firm's minimum acceptable limit to pursue a project to evaluate its overall conditions. Accordingly, each participant assigned to the model-assisted group was asked to make a bid decision based on the computational model outputs. This model is explained in more detail in Han and Diekmann (2001).

Results and Findings

The results are presented in the following order: (1) Risk attitude regarding different decision tools, different project conditions, and the decision maker's experience; (2) the decision makers' different perceptions on definite go and definite no-go profitability, and minimum acceptable limit as a function of, project conditions, the subjects' experience and their nationalities; and (3) reasons for errors in the bid decision.

Risk Attitude Regarding Different Configurations

The results of the bid decision are shown in Table 4. Of the 91 participants, 31 participants made an optimistic bid decision, while 60 participants made a cautious no-bid or intermediate decision. In more realistic situations where subjects made decisions against different projects, 23 out of 30 participants made a "no-bid" or "intermediate" decision against Case 1 (moderate project) which indicated that 76.7% made the correct decision. The participants of Case 3 (good project) showed a similar result (74.2%), while most subjects (28 out of 30 subjects) made a perfect "no-bid" decision against Case 2 (bad project). Specifically, for the intuition-based participants, around 42% of the subjects assigned to the Case 1 and Case 3 groups made wrong decisions (13 out of 31 subjects). In contrast, most of the subjects assigned to the Case 2 group made almost perfect decisions regardless of their decision tools.

Table 5. Indications of Risk Attitude with Respect to Decision Criteria

		Profit % of “definite go”	Profit % of “definite no-go”	Weighting ratio	Minimum score to go
Average values		10%	0.40%	67:33	70.4
Project conditions	Case 1	9.2%	1.4%	64:36	69
	Case 2	10.3%	0.8%	72:28	74
	Case 3	10.4%	−0.8%	63:37	67
Subjects’ experience	Novice	8.8%	0.7%	61:39	63
	Industry	11.4%	−0.4%	70:30	73.5
Nationalities	North Americans	11.0%	1.40%	72:28	73.6
	Koreans	9.0%	−2.8%	60:40	63.8

The distinctive point to note is that decision makers generally make good decisions for bad projects by screening unfavorable factors, but they get confused by risk aversion behavior when making the same decision for good or moderate projects. As a consequence, they lose good profit making opportunities by abandoning potential projects. On the other hand, in the case of the model-assisted group, most subjects could arrive at a correct decision regardless of different project conditions (93.3% correct). In conjunction with this result, we conclude that a fundamental function of the decision support model lies in its ability to prevent a decision maker from missing a good profit making opportunity by mitigating severe risk-avoidance behavior rather than staying safe due to several repellent factors.

This highlights the fact that risk attitude on bid decisions for international projects depends not only on the decision mechanism, but also upon an individuals’ predisposition to minimize possible loss. These findings coincide with the previous study by other researchers (MacCrimmon and Wehrung 1986): (1) Decision makers are more risk averse in opportunity situations than in threat situations [Eight subjects made no-bid or intermediate decisions for Case 3 (good project)], (2) decision makers are extremely risk averse when the chance of loss was too high [only two subjects made “bid” decisions for Case 2 (bad project)], and (3) decision makers are more risk taking for business decisions involving losses than involving gains [Seven subjects made bid decisions for Case 1 (moderate project)].

Additionally, we did not find a strong relationship between the subject’s risk attitude (“Step 1” test) and their bid decision behavior (“Step 2” test). For example, participants who exhibited a risk averse attitude in the Step 1 did not necessarily make a no-go decision for Case 1 (moderate project) or Case 3 (good project) in the subsequent Step 2 test. In other cases, risk seekers often made a no-go decision for Case 3 in the realistic bid decision test, indicating that the participants in the procedural tests appear to be inconsistent. It implies that people are likely to behave differently between the individuals perspectives and those when taking on the role of a firm’s executive in making a more realistic bid decision on complicated international construction projects.

In turn, we performed an analysis of variance (ANOVA) to determine if a dependent variable can be affected by two or more factors. The null hypothesis is that there is no difference in terms of decision types (bid, no-bid, intermediate) and decision correctness between the decision tools, experience, and project conditions. The result of combined effects shows that with the degree of freedom of 85, the F-values are above 3.496. This value is greater than that of the corresponding F-value at the 5% level. It indicates significantly high differences in the decision types and

correctness with respect to different decision tools, project conditions, and subjects’ experience.

Risk Attitude in Terms of Marginal Profitability

When determining a bid decision by the decision support model, each subject was asked to indicate their perceived profit of definite go and definite no-go, weighting ratio between profit and other project benefits, and “minimum acceptable point” by which they would choose a bid or no-bid. We investigated the risk attitude through the following question: “Are these answers different with respect to the project conditions, participant’ experience, and their nationalities?” Table 5 shows the details of our findings.

Although there was not a significant difference between the three projects, a bad or a moderate project reveals slightly higher values in definite go, definite no-go, weight of profit, and minimum score to go. It can be explained by the fact that decision makers become more risk averse and require stricter standards to make a bid decision when they are confronting bad projects. The second point to note is that industry participants were more risk averse than novices. Industry participants indicated higher values in the minimum allowable profit of definite go, weighting ratio, and minimum acceptable points. Typically, decision makers with more experience were more risk averse.

In addition, 41 Korean subjects (20 graduate students, 21 industry companies) represented more risk-taking values than those of North American participants. Particularly, they replied “−2.8%” profit for definite no-go. The negative value means that they are willing to go if the other project benefits could be enough to outweigh the loss. Additionally, they put a low minimum acceptable point to decide to go (63.8 point) in comparison to that of the North American participants (73.6 point). We assume that this result is due mainly to the differences of both cultural and business climate.

Reasons for Errors in Bid Decision

Further, we investigated the reasons for errors in the processes of bid decisions. As noted, decision makers were confounded by the complexity of the circumstances. There were numerous factors that caused the subjects to make incorrect decisions. We found two types of incorrect decisions: (1) Type I: A bid decision for bad or moderate projects (total nine occurrences) and (2) Type II: A no-bid decision for the good project (total eight occurrences). Most Type I errors were made by the novice group, while Type II errors were from industry participants. In contrast with Type I errors, which resulted from temptation created by several positive

factors, Type II errors occurred mainly due to negative factors (for example, unfavorable political/economic risks, government control, and competitive bid type) and subsequent exhibition of an extremely risk-averse attitude against the international opportunity.

Subject Feedback and Discussions

To determine whether the participants who made wrong decisions would change their initial decisions given the further information generated by a decision support tool and other experts' opinions, we conducted feedback with participants. Among 17 incorrect subjects, ultimately ten participants were willing to join the subsequent test. Among them, four subjects belonged to the industry group ("Case 1": One, "Case 2": None, "Case 3": Three) and six were from the novice group (Case 1: Four, Case 2: One, Case 3: One). We asked if they would like to change their initial decisions for any reason. As a result, seven subjects changed their previous decisions that were originally incorrect. The following are main findings:

1. Three out of four subjects assigned in Case 3 (good project) judged positively with the additional positive information. They were more inclined to support a "bid" decision because of high subsequent profit and relatively favorable conditions, such as minimal schedule risks, unit price contract, and the soundness of the funds financed by the World Bank. Note that the favorable information can lessen the severe risk aversion in pursuing a profitable project.
2. One subject involved in the Case 2 (bad project) corrected his decision because the Case 2 project is too risky to justify pursuing. The negative factors such as higher political instability, low profit margin (lump sum contract), and unreliability of funds forced him to change his original decision.
3. Three out of five subjects involved in Case 1 (moderate project) changed their initial decisions into no-bid. However, two subjects were not swayed because they would expect other benefits such as the potential for future markets despite its low profitability.

In terms of the feedback results, it is fairly straightforward to note that the subjects who made errors in making bid decisions due to their risk avoidance can arrive at right decisions in a complex project condition if they are provided with appropriate information, the support of decision support tools, and an expert's consensus opinion. Based on the experimentation tests and feedback, we make the following suggestions regarding the lesson learned and the appropriate application to future project selections:

1. There is a long history of previous studies indicating that business people, when making a decision under uncertainty, have a tendency to be risk averse. Although people tried to make good decisions, both novices and industry participants repeatedly showed that intuition based decisions were flawed by the complexity of uncertain information and several biases due to risk aversion. Accordingly, appropriate project selection should rest in how to lessen the risk aversion by the adoption of risk and decision analysis tools.
2. While the decision support model increases the decision correctness for all groups, it is more helpful for novices than for experienced industry professionals by helping them avoid undesirable risk aversion in capturing potential opportunities. Subsequently, the decision tool aims at aiding inexperienced

people to lessen possible errors and assisting experienced decision makers to mitigate risk avoidance.

3. The bid and no-bid decision requires both historical data and an expert's subjective assessment to evaluate the potential benefits and possible drawbacks of new projects. Often, it is difficult to get the appropriate information due to the possibility of personal bias. Particularly, the company should estimate the risk variables using both available historical data and expert judgments to lessen any possible biases and the tendency toward risk avoidance.
4. The subjects perceived that the top ranked factors in the case of bid decision are "possible project profit," "well-defined project scope," "possibility for future market," and "firm's desire for international markets." On the other hand, participants felt differently regarding the factors for the no-bid decision, such as "low profit/gain," "amount of risks," "owner's factor such as bad reputation and no existing relationships," and "currency devaluation." The multicriteria integrated model platform is desirable to incorporate these important factors.
5. A company seldom confronts such opportunities that decide a definite-go or definite no-go in the real business environment. It is desirable for a firm to set up strategic alternatives to improve project conditions in real situations. Finally, test results denoted that people preferred a higher expected return to some extent, but concurrently they did not prefer higher variation in return in choosing international projects. The possible trade-off between expected value and variation among different international projects should be married to the qualified project selections.

Conclusions and Future Recommendations

This paper investigated the risk attitude in the selection of international projects, which are manipulated to have various levels of uncertainty in the international business domain. Some of the errors and biases due to the risk aversion in the bid decisions were examined. Based on the measurements of the procedural tests, we concluded that decision makers felt it was more difficult to make a decision for "good project or moderate project" than for "bad project." Subsequently, they were very conservative in pursuing probable projects. Primarily, these findings in this domain were analogous to the previous research in cognitive/judgment psychology, which have resulted in the common assumption of risk attitudes in the process of decision making under uncertainty.

Limitation of this research includes the results obtained from a small sample size. While attractive test results were obtained from 91 active participants, the numbers are not enough to perform more comprehensive statistical analysis. The limitation resulted mainly from the fact that the procedural tests took a long time to complete. Many prospective test subjects the writers contacted were not willing to spend that much time for the research. However, encouraged by the test results, we intend to focus our future research on the extension of the current study for in-depth risk attitudes in terms of different projects with more varieties of risk profiles, different decision makers' personal backgrounds, such as seniority, age, education, firms' size, and more diversified nationalities. Further, it can be valuable to test the decision makers' ability to distinguish between good and bad projects based on the different combination of judgment cues such as expected return, risk (variance of project profit), return on investment, and other valuable project benefits.

Appendix I. Survey for Measuring Risk Attitude

Direction

This is an experiment in bid decision making. Suppose that you are interested in overseas projects, but also concerned about risky situations in a highly uncertain business environment. You are presented with three separate decision tasks.

Choice between two alternatives (in the profit case)

You are asked to specify how much sure payoff must be received for you to be indifferent between the expected value of the given risky investment that is not certain (option A) and the sure payoff (option B).

Option A (expected monetary value equals \$2 million dollars)

- Optimistic: gain \$20 million dollars with a probability of 0.3
- Most likely: gain \$5 million dollars with a probability of 0.4
- Pessimistic: loss \$20 million dollars with a probability of 0.3

Option B (sure outcome offers)

You need to make a decision whether to choose a risky opportunity or a certainty outcome. Please decide to accept or refuse the following offers;

1. If another firm suggests that you sell a risky investment opportunity for \$1 million dollars, would you accept it?
☐ Yes ☐ No ☐ Indifferent
2. If another firm suggests that you sell a risky investment opportunity for \$2 million dollars, would you accept it?
☐ Yes ☐ No ☐ Indifferent
3. If another firm suggests that you sell a risky investment opportunity for \$3 million dollars, would you accept it?
☐ Yes ☐ No ☐ Indifferent
4. What is the marginal sure price to decide to sell your risky investment opportunity that is equivalent in your mind to a given situation involving uncertainty?
()
5. What are the four most critical factors which affect your decision? Please rank the flowing factors in order (for example, ①→②→③→④).
① chance of loss ② chance of success ③ amount of significant loss ④ amount of significant gain ⑤ expected return ⑥ offered sure outcome ⑦ (list other factors)

Choice between three alternatives (tradeoff between return and variation)

You are asked to rate your preferences among three different alternatives. This test is designed to evaluate the possible trade-off between expected return and variation among different international projects.

Option A (expected return: \$3.5 million, standard deviation: \$5.9 million dollars)

- Optimistic: gain \$10 million dollars with a probability of 0.3
- Most likely: gain \$5 million dollars with a probability of 0.4
- Pessimistic: loss \$5 million dollars with a probability of 0.3

Option B (expected return: \$7 million standard deviation: \$19.5 million dollars)

- Optimistic: gain \$30 million dollars with a probability of 0.3
- Most likely: gain \$10 million dollars with a probability of 0.4
- Pessimistic: loss \$20 million dollars with a probability of 0.3

Option C (expected return: \$12.5 million, standard deviation: \$46.5 million dollars)

- Optimistic: gain \$70 million dollars with a probability of 0.3
 - Most likely: gain \$15 million dollars with a probability of 0.4
 - Pessimistic: loss \$50 million dollars with a probability of 0.3
1. Please rate your preferences among three alternatives with different risk profiles by using an index number, ranging from 1 (least preferable) to 7 (most preferable) and then rank them in order.

• Option A () Option B () Option C ()

• Rank (→ →)
 2. What are the four most critical factors which affect your preferences? Please rank the flowing factors in order (for example, ①→②→③→④).
① chance of loss ② chance of success ③ amount of significant loss ④ amount of significant gain ⑤ expected return ⑥ variation in return (standard variation) ⑦ (list other factors)

Appendix II. Survey for Bid Decision (Case 1)

Direction

Suppose that a construction firm would like to seek opportunities abroad. Among the international markets, particularly, the company is highly interested in Asian-Pacific Rim countries because this region is one of the strongest construction market in the world. However, the company is also concerned with critical changes and the uncertainties currently confronting Asian countries. Therefore, the company needs to make a hard decision as to whether to bid/no-bid the project with due precautions.

What Decision Has to Be Made?

To do business successfully, the decision maker wants to get reliable and sufficient information to decide whether to pursue the projects by evaluating:

1. Potential profitability of the project (probability of loss/gain)
2. Amount of risks involved, types of controllable/uncontrollable risks
3. The firm's ability to perform the project (the firm's qualification for the project)
4. The firm's competitiveness to win the contract
5. The strategic importance to the future of the company (developing new relationships, gaining future markets)
6. The firm's minimum level of goals to make decisions (*cut-off points*), etc.

Project Boundary Conditions

The following are boundary conditions, which are given initially based on bid documents.

1. Owner: Laos Government (Electric Du Laos)
2. Project type: Power plant construction (Approx. \$250 Million)
3. Bidding system: Open competitive bid

- Contract type: Fixed fee (lump sum) with escalation clause for rising material and labor, etc.
- Total duration: 48 months (1998–2001) with relatively strict schedule completion penalties.
- Payment methods: 50% in U.S. dollars, 50% in local currency. Currency: 42.3 Baht=\$1 U.S.
- Timing of payments: Based on milestone date (normally monthly basis)
- Financing aid: The owner will receive financing aid from World Bank, which provides sound financial capability.
- Applicable contract law: International standard contract written in both the local language and English.
- Risk sharing: The Laos government is responsible for *force majeure* risks.
- Tax reduction/exempt conditions: Tariff exempt, Income Tax Reduction provided based on international trade agreements

Important Information

- The company is not familiar with the business environment in Asian countries. Moreover, the company does not have an existing relationship with the owner.
- The company has market goals to enter into the growing Asian countries. The company has sufficient resources to do additional work and is eager to seek overseas projects to satisfy need for work.
- The Laotian government is responsible for managing the entire project. The degree of government intervention and control is known to be very high. In addition, this country has an unstable political system and there is a large amount of political bureaucracy.
- There are several competitors. By considering the various factors, the company anticipates the winning probability as 25%. If the company loses the bid, the bidding cost (about \$250,000) will be lost.
- The company has performed numerous domestic power plant projects, but never performed this type of project in the international market. However, the company feels that they can perform this project successfully because they have sufficient experience with this type of project in the domestic market. In addition, the company has technological advantages in designing and implementing specific power plant equipment.
- In addition, varieties of uncertainties involved in the project settings are provided in the following table so that you can evaluate the uncertain project conditions based on your judgments about each risk variable (The details are omitted).

The main questions

- Decide to bid or no bid.
- Identify the three most critical risk factors which affect your decision.
- What type of strategic alternatives (i.e., alliance) can you identify to mitigate/avoid risk variables?

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