S19-7

PROGRAMMATIC AND PROJECT-LEVEL RISKS: ESTABLISHING A RISK MANAGEMENT PROCESS FOR MIDDLE EAST PLANT PROJECTS

G. Edward Gibson, Jr. [1], John Walewski[2], SangBum Kim[3], Clayton Ingam[4], and

Hamid Hajian[5]

[1]Professor, University of Alabama, Tuscaloosa, Alabama
[2]Assistant Professor, Texas A&M University, College Station, Texas
[3]Assistant Professor, Dongguk University, Seoul, Korea
[4]Graduate Student, University of Alabama, Tuscaloosa, Alabama
[5]Graduate Student, University of Southern California, Los Angeles, California
Correspond to: jwalewski@civil.tamu.edu

ABSTRACT: Research sponsored by the Korean Government investigated the establishment of a risk management process by Korean contractors involved with plant projects in the Middle East. This research effort builds upon the work completed by the Construction Industry Institute (CII), called the International Project Risk Assessment (IPRA) tool and method, and also explored how CII's Project Definition Rating Index (PDRI) could be incorporated to improve project planning by addressing risks and scope development issues. Specific findings and recommendations were developed including the creation of the Contractor Critical Areas of Concern (CCAC) risk screening tool for Korean contractors pursuing Middle East oil and gas projects.

Keywords: Construction Risk, Plant Projects, Project Definition Rating Index (PDRI), International Project Risk Assessment (IPRA)

INTRODUCTION

Contractors often face the reality that executing a construction project is a complex process that can be influenced by a variety of factors. Traditional project risks such as cost overruns, schedule delays and substandard quality are heightened by volatile materials and labor markets, tight financing and insurance markets, incomplete plans and specifications, and changing regulatory requirements. Add in the complexities of a contractor undertaking projects outside of their home country, and the result is a greater incidence of costly delays, disruptions and disputes.

The *Global Construction Survey 2005* by the management consulting firm KPMG gathered together the views of chief executive officers and senior executives of large international construction contractors operating in the U.S., Europe and Asia Pacific regarding their views on the challenges they faced, their risk management practices and the future of the construction industry. According to the *Survey*, managing contracting risk and properly pricing it is one of the key challenges that the industry faces, and 63 percent of respondents said it was their biggest issue. As such, proactive risk identification and assessment will have significant benefits when an organization incurs such risk and is in the proper position to apply adequate mitigation and management strategies. Furthermore, getting senior management aware of the breadth of international construction risks will further improve project performance by reducing the potential for more self-induced risk.

In general, risk management and loss control in the construction industry is reactionary, and there is a lack of effort to improve such practices by both contractors and owners. To be most effective, risk methodologies and management tools must be proactive rather than "just reacting to what happens." A critical issue to address is the need for both project management organizations as well as senior executives to be involved supporting management tools that can lead to proactive and preventative measures. A critical first step in this effort is to communicate the need for such strategies and to document this problem with the risk management community.

Korean contractors have improved their project delivery process and procedures to address the challenges of completing international construction projects on time, within budget, while ensuring facilities are well built. However, the risks associated with oil and gas/plant projects, and specifically those located in the Middle East, generally are high given the various technical and user requirements, unique logistics, and global political issues. Various risks and uncertainties are inherent to those involved in the design and construction work including such issues as: the recent increased demand for energy related projects, shortages of qualified subcontractors, laborers, and specialized materials; transportation and logistics difficulties; and political/social unrest.

The impetus for this study, funded by the Korean Ministry of Construction, was the recognized necessity to improve the performance of Middle East plant (oil and gas) projects in the wake of recent, less than desired performances by Korean contractors when undertaking such ventures. Although individual companies have pursued efforts to improve how they manage the risks associated with such efforts, a comprehensive industry-wide effort is expected to benefit individual projects and firms as well as the industry as a whole. The following sections provide an overview of the research effort to develop a risk management process for the delivery of capital facility projects by Korean contractors involved with the heavy industrial sector in the Middle East.

Specific objectives of the study included:

- Collection and assessment of a project-based dataset, including comparison to historical numbers captured in the previous.
- Conduct a review and assessment of risk identification, assessment and management tools used by organizations for international projects.
- Develop a modified version of the IPRA that will align Section I elements and descriptions to a contractor's perspective.
- Investigate the incorporation of the IPRA and the PDRI as a framework to quantify how risk likelihood and impact affect project cost and schedule.
- Develop a "short list" assessment mechanism or tool based on the data analysis to assist decision making and risk mitigation for contractors pursuing oil/gas projects in the Middle East.
- Conduct a workshop with contractor involvement and feedback to capture contractor input as well as collecting project data with the modified IPRA.
- Develop training to help facilitate acceptance and usage of this process.

Purpose

The purpose of this research was to review and assess current Korean Contractor procedures related to risk identification, assessment, and mitigation for international projects, and to introduce and apply the recently developed Construction Industry Institute (CII) International Project Risk Assessment (IPRA) management tool, as well as CII's Project Definition Rating Index (PDRI) on selected projects.

This research was broken into two phases. In general, Phase I consisted of data acquisition, analysis, and an overview and initial assessment of how the IPRA could be modified for this application. Phase II of the research provided a follow-up to the Phase I report and provided a more in-depth review of the risks associated in the Middle East oil and gas market for major plant facilities, including a detailed assessment of Korean contractor completed projects from Phase I, as well as analysis of an additional set of projects. The overarching scope of this investigation was to develop a methodology specifically for Korean contractors to assess the risk of Middle East plant facilities at appropriate points during project planning, especially just prior to contract formation.

The remainder of this document briefly introduces the IPRA, provides a discussion of the results from the Phase I and Phase II studies, and the benefits of a combined IPRA/PDRI program to enhance the project delivery process for international projects undertaken by Korean contractors are then presented. The CCAC tool is described and its use outlined. The report concludes with an overview of the process and procedure we consider as opportunities for improvement based on our assessment.

RISK ASSESSMENT FOR INTERNATIONAL PROJECTS

An international project can be defined as a project performed by investors, owners, and/or contractors located in a sovereign country outside of their typical operational jurisdiction. Assessing and managing risk is a complex and critical task for international construction projects, yet few evaluation tools and guidelines exist to assist owners and contractors with capital facility planning and construction.

In order to improve international construction project performance it is critical that consideration be given to the portfolio of risks that occur to all participants across the life cycle of a project. Many of these risks are jurisdictionally-specific. Because no common and overarching methodology to assess and manage these risks exists, owners, investors, designers, and constructors do not fully recognize, and realize, the value of systematic risk management process. Differing objectives and adversarial relationships between the parties are common. Attempts at coordinating risk assessment and management between all of the project participants have not been formalized and this is especially true between contractors and owners.

The International Project Risk Assessment (IPRA) tool

Based on the need for a process to enhance the assessment and management of international project risks, a structured risk identification and assessment process — known as the International Project Risk Assessment (IPRA) tool — was developed by the Construction Industry Institute's (CII) Risk Analysis for International Projects Project Team (PT 181). The IPRA identifies and describes 82 issues that are the critical elements related to an international capital project and allows the project team to focus on risk factors of potential concern.

Project data from over 25 countries on six continents were used to develop and validate the IPRA, and over 55 industry organizations participated. Credible risk rankings were developed for the tool using input from 44 participants on projects totaling almost $23 billion U.S. dollars (USD). The IPRA tool was validated on completed and ongoing projects representing over $4.2 billion in total installed cost. It has proven its effectiveness in identification of risk issues specific to international projects.

The IPRA is intended to evaluate the risk exposure and provide an indication of potential impact of risk during the full project life cycle. In effect, it can serve as an "aide memoir" for the project participants. The IPRA indicates which issues of the project should be considered for risk mitigation and control as part of an overall risk management strategy.

The IPRA tool contains a total of 82 potential risk elements for an international project, as well as the rank order list of those risk elements identified by the CII research effort as having either an extreme or significant relative impact, and/or were considered to be go/no-go type decisions.

In Phase I of this research project, several of the elements were considered not applicable to Korean contractors as given in Table 1. As part of this Phase II effort, the entire 82 IPRA risk elements were evaluated in conjunction with the research team and selected Korean contractor personnel to ensure their applicability to Korean contractors.

Table 1. IPRA Risk Elements with Significant Frequency (4 or more projects) of Not Applicable from Phase I Study

IPRA Element	8. Element Description	Frequency
I.A1	Business case	6
I.A2	Economic model/feasibility	7
I.A3	Economic incentives/disincentives	7
I.A4	Market/Product	9
I.A5	Standards and practices	5
I.A6	Operations	5
I.A7	Tax and Tariffs	4
II.A2	Value added tax	4

Addressing all 82 elements, many were rewritten to focus more on Korean Contractor specific issues. In addition, the operative risk consideration of each element was highlighted in bold italics in order to emphasize the risk focus that contractors should address.

Assessing risks on an international venture should take into consideration all key participants to the project. The value of identifying and managing project risks holistically, rather than individually, include:

- Early identification of hazards and opportunities
- Communication of risks between project participants
- Identifying and managing uncertainty, while considering worse-case scenarios
- Establishing ownership of risks and risk mitigation actions
- Enhancing risk-based decision-making

The IPRA analysis is focused on issues that are unique to ventures in an international jurisdiction. Other project management tasks such as scope definition, design management, team processes, relationships, project controls, and others must also be adequately performed in order for the project to be successful.

The IPRA provides a structured methodology for project teams to identify and assess risk issues that are international project specific. An element's risk involves two components: 1) the likelihood of occurrence, or in many cases, the likelihood that there will be a change to what is expected, and 2) the relative impact of that occurrence. The combination of the two factors using the IPRA Risk Matrix provides the coordinates to determine the Relative Importance of the risk.

Other Risk Management Procedures and Practices

Risk has different meanings to different people, and the concept of risk varies according to viewpoint, attitudes, and experience. Engineers, designers, and contractors often view risk from a technical perspective, while owners and developers tend to view it from the economic and financial side. Because the objectives of construction projects are usually stated as targets established for function, cost, time, and quality, the most important risks in construction are the failure to meet these targets.

CII's definitive work on construction risks (CII 1988) uses classic operations research literature to distinguish the concepts of risk, certainty, and uncertainty, and is consistent with the literature on what is considered as the sequential procedures for construction risk management: identification, assessment, analysis of impact, and management response.

Increased concerns about project risk have given rise to various attempts to develop risk management methodologies. An example of such is the Risk Analysis and Management of Projects (RAMP) method produced by the Institute of Civil Engineers and the Institute of Actuaries in the United Kingdom. This method uses a project framework to identify and mitigate risk by using risk identification and project controls to focus on risks as they occur during the project life cycle. Their method requires users to follow a rational series of procedures and to undertake this analysis at scheduled intervals during the life cycle of a project. RAMP applies to all types of project but does not focus specifically on international issues.

Much of the research related to risk identification for constructed facilities is focused on specifics such as location, categories of risks aspects, or types of projects. For example, lists of relevant construction project risks have been developed as well as lists of political risks are available. There are also numerous methods of identifying risk such as interviews, questionnaires, and in-depth reviews by knowledgeable staff or consultants.

Risk assessment for construction can also be associated with probabilistic analysis. The use of probabilistic sums to calculate ranges of cost-estimates is a common practice in the construction and financial industries and this step in the risk management process is often referred to as risk analysis. There are a variety of risk analysis methods with the majority emphasizing quantitative techniques such as sensitivity testing, Monte Carlo, and expected net present value. Such approaches require events to be mutually exclusive, exhaustive, and conditionally independent. However, construction involves many variables, and it is often difficult to determine causality, dependence and correlations.

In the development of the IPRA a variety of risk identification and assessment tools were reviewed. Most of the organizational processes provided to the researchers were done with a pledge of confidentially in exchange for a candid discussion and review of the procedures and practices by individual organizations. In addition, the vast majority of procedures provided were given by owner organizations. The owner heavy response reflected the reality that there were few contractors that had a documented risk management process in place at the time of the research project. In addition, no one tool was found to be comprehensive in nature and focused specifically on the risks associated with international projects.

Application of the PDRI

Research by CII and others has shown that project success is highly dependent on the level of effort expended during the early stage of the project. Such research has also found that success during the detailed design, construction, and startup phases of a project highly depends on the level of effort expended during the scope definition phase as well as the integrity of the project definition package. Gibson and others have identified several issues including standardizing the front end planning approach, having the proper expertise during planning, as well as appropriate individuals, and end users involved as critical factors for better front end planning. A series of CII research studies found that risk management tools for measuring project scope definition and assisting alignment between project participants were needed, and as a result, the Project Definition Rating Index (PDRI) tools for industrial and building projects, as well as the team alignment model were developed to help determine the level of scope definition.

The structure of the industrial PDRI is similar to the IPRA in that it follows the Section, Category, Element hierarchy. The PDRI consists of the following:

Section I: Basis of Project Decision – Selecting the "right project"

- Three categories, 18 elements

Section II: Basis of Design – Selecting the "right product"

- Four categories, 32 elements

Section III: Execution Approach – Doing projects the "right way"

- Four categories, 14 elements

Some of the risk issues identified by Korean contractors in Phase I are issues that the PDRI is designed to identify and measure.

Other PDRI elements such as feedstock availability and environmental assessment are addressed at various points in the PDRI. Given the frequency of PDRI element issues identified as well as the desire to develop a tool to better understand the risks during the early stages of project development, the previously-mentioned PDRI Elements are among those were studied during Phase II of the research with four specific PDRI elements chosen to be included in the development of the tool.

REVIEW SESSION STRUCTURE AND PARTICIPANTS

Nine IPRA assessments were conducted on recently completed Korean contractor projects using the CII published version of the IPRA in June 2006 as part of Phase I. Eight of these were heavy industrial/plant projects located in the Middle East and one was located in Malaysia. Table 2 provides a list of the projects by location and type. To facilitate confidentiality, only general project information is provided in Table 2 and this level was maintained throughout the research effort.

Table 2. Evaluated Projects, Phase I

Phase I Project Number	Location	Project Type
1	Saudi Arabia	Process/Chemical
2	Kuwait	Oil/Water Treatment plant
3	Kuwait	Refinery
4	Qatar	Process/Chemical
5	Saudi Arabia	Process/Chemical
6	Libya	Gas Production
7	Kuwait	Heavy
8	Kuwait	Gas production
9	Malaysia	Process/Chemical

During Phase I of the research, the project managers for each project were first asked to complete the background information questionnaire and most of these were completed and brought to the review session. To rate the risk elements, the assessors were instructed to read its definition and then assign an appropriate risk level based on their perception of known or perceived risk at contract formation just prior to project execution. The authors led the group through each of the 82 elements where first the likelihood of occurrence was determined, and then the assessors used either the IPRA baseline weight consequence or use a self-determined relative impact based specifically on project issues.

Assessment sessions were conducted without difficulties and the contractor personnel had minimal problems understanding the assessment format and purpose of the reviews. Each project assessment took approximately two hours to complete.

In Phase II, two seminars to approximately fifty invitees were provided and the results of the Phase I study were presented, along with a discussion of the IPRA, PDRI, and a draft version of the CCAC. Data from a total of four additional projects were collected after the seminars and the location and project types are given in Table 3. In total, Phases I and II captured project data from a total of five Korean contractors.

Table 3. Evaluated Projects, Phase II

Phase II Project Number	Location	roject Type
B1	Libya	s Production
B2	Libya	ver Plant (CC)
B3	Indonesia	er Plant (Gas)
B4	Indonesia	s Processing

It should be noted that limited information was obtained from the questionnaire regarding project costs and schedule performance in Phase I. Table 4 details the performance information that was obtained from the questionnaires distributed to Korean contractors in Phase I. As shown in Table 4, only two contractors provided actual cost results, although eight of nine provided schedule results. During Phase II, an attempt was made to obtain additional data however, only one project (project 6) provided performance information related to cost; therefore no additional analysis was possible in this area. Overall, there was very little schedule difference from planned to actual; three projects were completed up to one month ahead of schedule, whereas, one project exceeded the planned schedule by two months.

Table 5 provides details about the performance of sample projects captured in Phase II. The financial performance of the four sample projects varied widely. All respondents provided actual cost results, and three of four provided schedule results. All sample projects were reported to be within 5 percent of the project cost performance. Overall, there was some variation with schedule; one project was two months ahead of schedule, one five months behind and the other on schedule. Project B2 was in the construction phase, so final schedule data was not available, although it was apparently behind schedule at this point.

OVERVIEW OF PROJECT EVALUATIONS

For the nine Phase I sample projects, a weighted average mechanism was developed to determine which IPRA elements seemed to cause the most problems on the evaluated projects. The emphasis of the IPRA is to focus on the risk elements that have been identified (scored) as having a very high (5) or high (4) likelihood of occurrence, and/or an extreme (E) or significant (D) relative impact. As with the original version of the IPRA, the assessments were undertaken to ultimately identify the relative importance of the individual elements so that project managers and others associated with the project prioritize mitigation base on the combination of impact and likelihood. The most critical risk elements for the nine projects are shown on Table 6.

Table 4. Performance Information Obtained From Questionnaires in Phase I

Phase I Project Number	**Location**	Project Type	Financial **Performance 1 to 5 scale[1]**	Cost **Info Provided[2]**	Schedule **Info Provided[3]**
1	Saudi Arabia	Process/Chemical	3	L	L
2	Kuwait	Treatment plant	1	Y	Y 0[4]
3	Kuwait	Refinery	4	N	Y -1
4	Qatar	Process/Chemical	5	N	Y -1
5	Saudi Arabia	Process/Chemical	5	N	L
6	Libya	Gas Production	1	Y	Y -1
7	Kuwait	Refinery	4	L	Y +2
8	Kuwait	Gas production	4	N	Y 0
9	Malaysia	Process/Chemical	3	L	Y 0

[1] Scale of 1 to 5 with 1 being falling far short of expectations to 5 being far exceeding expectations.
[2] L = limited information provided; Y = information provided; N = no information provided.
[3] L = limited information provided; Y = information provided; N = no information provided.
[4] Number is related to months ahead or behind actual delivery (0 = on schedule).

Table 5. Performance Information Obtained From Questionnaires in Phase II

Phase II Project Number	**Location**	Project Type	Financial **Performance 1 to 5 scale[1]**	Cost **Info Provided[2]**	Schedule **Info Provided[3]**
B1	Libya	Gas Production	4	Y 0	Y +2
B2	Libya	Power Plant (CC)[5]	1	Y 0	L
B3	Indonesia	Power Plant (Gas)	3	Y 0	Y 0
B4	Indonesia	Gas Processing	3	Y 0	Y-5

[1] Scale of 1 to 5 with 1 being falling far short of expectations to 5 being far exceeding expectations.
[2] L = limited information provided; Y = information provided; N = no information provided.
[3] L = limited information provided; Y = information provided; N = no information provided.
[4] Number is related to months ahead or behind actual delivery (0 = on schedule).
[5] CC is an acronym for combined cycle

Table 6. Most Critical Risk Elements for Middle East Projects

IPRA Element & Description	**Rank**
I.B2. Currency	1
I.B3. Estimate uncertainty	1
III.D10. Safety during construction	1
III.D8. Schedule	4
III.A7. Approvals/permits/licensing	5
II.D4. Contract type and procedures	6
III.C4. Constructability	7
II.A7. Corporate income tax	8
I.B1. Sources & form of funding	9
III.B3. Subcontractors	10

The three key factors identified by project managers from the retrospective reviews were:

1. ***Currency issues (element I.B2)*** **–** Cost inflation shrinks the purchasing power of a currency and the long term nature of large plant projects creates issues regarding currency. Furthermore, a contractor's operations will be affected by changes in the rate at which one currency may be converted into another, and currency restrictions can provide additional fiscal and time burdens and can reduce revenue.

2. ***Estimate uncertainties (element I.B3)*** – Given the increased demand for oil and gas resources from the Middle East and the impact of much higher than average labor and material costs, cost uncertainty is the norm for Middle East plant projects. In such an environment, detailed construction cost estimates are harder to develop and should take into consideration the specifics of each project and labor market.
3. ***Safety during construction (element III.D10)*** – Korean contractors have long been noted for their concerns about job site safety and it is not a surprise that this issue would be an issue where historical safety practices by in-country or non-native subcontractors are poor.

Seven additional issues that seemed to be problematic (in order of importance) include:

1. Schedule (element III.D8)
2. Approvals, permits and licensing (element III.A7)
3. Contract type and procedures (element II.D4)
4. Constructability (element III.C4)
5. Corporate income tax (element II.A7)
6. Sources& form of funding (element I.B1)
7. Subcontractors (element III.B3)

Issues not identified as critical areas of concern but could be of concern: *Political stability, social unrest, and security (elements II.B2, II.B3, and IV.A2).* In general, the Middle East is experiencing a degree of unrest, and some of the specific countries reviewed are experiencing strife or are in close proximity to countries that are. However, the issues often associated with country risks (political stability, social unrest, etc.) were not seen as key factors for the projects reviewed. This could be because most of these large scale projects were started in the late 1990s when such issues were less risky. Nonetheless, the planning, design, construction, and long-term operations of industrial/plant facilities requires the attention and consideration of the social and political issues that could develop, as well as how this instability can influence project feasibility, schedule, costs, and operations, especially if transport or logistics go through these area of unrest.

Because these Phase I assessments were retrospective project reviews, we were also interested in any differences in what was initially perceived and the final outcome for each risk element. For example, an item may have originally been considered a moderate risk but by the end of the project it was significant. The project questionnaire distributed to evaluation participants had a question that inquired which, if any, IPRA risk elements that had a significant impact were not addressed at contract formation. A summary of risk issues that caused problems, but were not anticipated at contract award for these completed projects are noted in the Phase I. Using this list which identified several additional areas of concern, and working closely with the HDEC team and the experience of the researchers, four additional issues affecting the technical delivery of the project were identified.

Other technical issues not identified as critical areas of concern but could be of concern: *Process and Instrumentation Diagrams (P&IDs), Equipment Status, Startup Requirements, and Procurement (elements G3, H1, P5, and category L from the PDRI).* In general, P&IDs, equipment status, and startup requirements are of critical concern for oil and gas facilities when contemplating contractual obligation. Poor P&IDs will probably lead to process design changes that will impact the execution of the project, which given the location of these projects may cause significant delays or cost problems. Equipment status and procurement are critically important because much of the critical pacing equipment and materials is manufactured or fabricated in locations outside of the Middle East, placing a premium on the integration of these issues into the project plan, budget, and execution approach. Failure to understand the impact of these issues can have a serious impact on the project. Finally, facility startup requirements in remote locations will place a premium on planning for logistic support, turnover and training, which again can have a significant impact.

In summary, the ten issues that were empirically identified in Phase I as critical risk issues and shown in Table 6 have been supplemented with seven additional issues based on a further evaluation of data collected in Phase I and in concert with the project team. These issues are:

1. Political stability (II.B2.*)
2. Social unrest/violence (II.B3.)
3. Security (IV.A2.)
4. P&IDs (G3)
5. Equipment status (H1)
6. Startup requirements (P5)
7. Procurement (L)

* represents the location of the element in the IPRA or PDRI

Additional Data Analysis

As part of the analysis performed with Phase II, the CCAC Primary and Secondary elements were analyzed using data from both Phase I and Phase II projects as given in Table 7 and 8. These tables show the frequency of relative impacts given in each of the questionnaires. In some cases, the issues were not applicable to the project, hence the total values are less than potentially possible frequencies in some cases.

As noted in Table 7, estimate uncertainly and schedule both had either high or very high impact on eight of the 13 projects. Approvals, permits and licensing and subcontractors were high or very high risk impacts on seven of 13 sample projects. Note that 58 of 124 total issues are high or very high for the primary critical areas of concern.

Table 8 shows that social unrest / violence and political stability were the two issues with the most potential risk impact in the sample. Note that 16 of 52 total issues are high or very high in the secondary critical areas of concern. In total, 74 out of 176 elements assessed for the 13 sample projects were rated in the high or very high impact area according to the respondents. In addition to comments provided in Phase I and discussed in the first report, some additional comments were provided by respondents in Phase II outlining specific problems as given below.

- Underestimated engineering volume due to the specialty requirements of gas projects
- Higher price for subcontractors than estimated
- Subcontractor's poor quality and time management caused problem
- Boycott to raise salary by subcontractor's workers delayed project
- Local laws changed severely, worsening the time needed to mobilize workers
- Poor scope definition and unclear contract terms because the client did not want to burden itself with all risks
- Schedule too tight for the scope of work
- Country's unstable political condition caused concern
- Time delayed for costumer clearance
- Pilferage and loss of material due to security problems

In addition to suggestions to mitigate the issues above, one respondent offered the following advice.

> "Providing good collaboration among stakeholders to understand the cultural differences is a must….our staff, labor and, subcontractors (need) to be carefully selected because sometimes client requests the use of designated subcontractors in contract."

Table 7. Primary Risk, Critical Areas of Concern, N = 13

Primary	Frequency of Relative Impact				
	Very Low	Low	Medium	High	Very High
1P. Sources & form of funding (I.B1.)*	7	0	1	0	3
2P. Currency (I.B2.)	2	1	4	4	2
3P. Estimate uncertainty (I.B3.)	2	2	1	4	4
4P. Corporate income tax (II.A7.)	7	0	1	1	3
5P. Contract type and procedures (II.D4.)	3	1	3	2	3
6P. Approvals, permits, licensing (III.A7.)	1	2	2	4	3
7P. Subcontractors (III.B3.)	2	1	3	4	3
8P. Constructability (III.C4.)	1	2	3	5	1
9P. Schedule (III.D8.)	2	1	2	4	4
10P. Safety during construction(III.D10)	4	2	3	0	4
Totals	31	12	23	28	30
* represents the location of the element in the IPRA or PDRI					

Table 8. Secondary Risk Areas of Concern, N = 13

Secondary	Frequency of Relative Impact				
	Very Low	Low	Medium	High	Very High
1S. Political stability (II.B2.)*	4	1	3	4	1
2S. Social unrest/violence (II.B3.)	5	1	1	4	2
3S. Security (IV.A2.)	5	3	1	2	0
4S. P&IDs (G3)	3	0	1	0	0

5S. Equipment Status (H1)	3	0	0	1	0
6S. Startup (P5)	2	0	1	0	0
7S. Procurement (L)	2	0	0	0	2
Totals	24	5	7	11	5
Note: Elements 4S through 7S not evaluated in Phase I					
*** represents the location of the element in the IPRA or PDRI**					

CONTRACTOR CRITICAL AREAS OF CONCERN (CCAC) TOOL AND ASSESSMENT

The researchers have developed the Contractor Critical Areas of Concern (CCAC) Tool to give a quick risk analysis procedure for Oil and Gas Projects in the Middle East. The research team identified 10 primary elements from the Phase I report and performance data. In addition, a set of seven secondary elements where comprised from areas of concern identified in the Phase I effort, as well as opinions of the authors and research sponsors as outlined in the previous chapter. Each element of the CCAC has a corresponding detailed description provided to assist with the understanding of each issue related to risk. It was envisioned that the CCAC score sheets, Critical Areas shown in Figure 1, would be used as a quick assessment by contractors of the severity and probability level (score) for each element of these elements as a check on whether to pursue the project. The CCAC Risk Thermometer shown in Figure 2 was developed so that an overall Project Risk Factor could be developed. The IPRA and PDRI may be used in conjunction with this tool to identify other areas of concern.

Philosophy of Use

The CCAC is best used as a tool to help contractors understand *high impact* risks and determine their relative importance to the project. The users should strive for consensus around each element before moving to the next. If action needs to be taken on an element, these should be recorded as action items. Using the CCAC early in the project lifecycle gives the project team a roadmap for control and mitigation. During this early phase of a project there may be several very important issues that can affect the overall viability of the project.

As stated, the user or project team conducts a CCAC evaluation at the preliminary stages of the project bidding process to gage the initial risk of the project. A neutral facilitator familiar with the process may be used to help in the discussion, along with appropriate members of the project team, optimizing the assessment and limits in-house biases. The facilitator provides objective feedback to the team and controls the pace of the meeting. When this arrangement is not feasible, the alternate approach is to have key individuals evaluate the project separately and then come together for consensus. Although personal reviews may be biased, using the CCAC from an individual point of view can be of merit.

Both senior management and project managers of the construction organization can use the tool. The CCAC Assessment Worksheets serves as a basis for risk mitigation and decision by the project team. The CCAC Risk Thermometer can be used as a summary roll-up for senior management, in effect, helping to bridge the communication gap concerning project understanding. In addition to the Risk Thermometer, the summary should also contain a brief write-up commenting on the specific areas of concern and summarize the CCAC analysis. This summary should be used to determine quickly whether or not to go forward with the project. In particular the assessment can pay attention to elements that show higher Relative Importance in the relative thermometer placement (Very Low to Very High). The lists of High risk elements are of particular concern. CCAC assessment results may change on a day-to-day or week-to-week basis as team members realize that some risk elements are not as critical (or more critical) or well defined as initially assumed. It is important to score the elements honestly.

Risk management is inherently iterative in nature and any changes that occur in assumptions or other project parameters need to be resolved with earlier mitigation plans. The relative importance of any specific risk concern may not be as important as the team's progress over time in resolving broader issues that harbor risk.

PROJECT NAME:						
	Likelihood of Occurrence (L)					
Issue	VeryLow	Low	Medium	High	Very High	Score
1P. Sources & form of funding (I.B1.*)	20	40	60	80	100	
2P. Currency (I.B2.)	20	40	60	80	100	
3P. Estimate uncertainty (I.B3.)	20	40	60	80	100	
4P. Corporate income tax (II.A7.)	20	40	60	80	100	
5P. Contract type and procedures (II.D4.)	20	40	60	80	100	
6P. Approvals, permits, licensing (III.A7.)	20	40	60	80	100	
7P. Subcontractors (III.B3.)	20	40	60	80	100	
8P. Constructability (III.C4.)	20	40	60	80	100	
9P. Schedule (III.D8.)	20	40	60	80	100	
10P. Safety during construction(III.D10)	20	40	60	80	100	
					Total Score	

*These Alpha Numeric Descriptions Correspond to IPRA or PDRI Description Elements

LEGEND
Likelihood of Occurrence
Very Low - Low probability and occurs in only exceptional circumstances (less than 10% chance)
Low - Low probability and unlikely to occur for this project (10% to 35% chance)
Medium – Medium chance and will occur in most circumstances for this project (35% to <65% chance)
High - High chance and will probably occur in most circumstances for this project (65% to 90% chance)
Very High - High chance and almost certain and expected to occur(90% to 100% chance)

Figure 1. Contractor Critical Areas of Concern Score Sheet

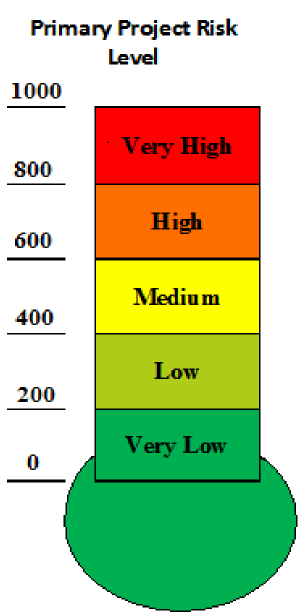

Figure 2. Contractor Critical Areas of Concern Risk Thermometer

In practice risk management is not often a clean process and if possible, the timing around when the tool should be deployed should be flexible. The tool should allow for those at the executive and project level to first make decisions and then help re-check those decisions as they move forward with project development. The authors realize that certain types of risks are very specific to the party involved in the project. However, a conscious decision was made to combine the owner and contractor perceptions into this one tool because of the benefits that perspective can bring to the parties at hand

A CCAC Assessment without a proper mitigation plan is probably not worth the effort. The CCAC tool and this document were purposely developed as an assessment approach. Because of the myriad of projects, countries and business sectors, providing specific risk mitigation advice for international ventures is not feasible. The tool and approach were therefore designed to be generic in nature (though focused on Middle Easter oil and gas projects) and give the project participants insight into what issues need to be mitigated. That said, mitigation is the key to bringing risks under control (or in avoiding unnecessary risks). This section therefore gives an overview of the risk mitigation process and some insight into the effort needed.

After using the CCAC tool to identify and assess the risks on international projects, the next step in effectively managing risks is to develop a risk response to achieve the project's objectives. This response to risk includes a plan, controls, and documentation.

The plan sets procedures, policies, goals, and responsibility standards for continuing the risk management process for the project. Generally, the plan should be based on the principle that responsibility for managing the risk should be assigned to those who are best able to address the source of risk in question.

Mitigating risk by lessening their impact is a critical component of risk management. Implemented correctly, a successful risk mitigation strategy should reduce adverse impacts. In essence a well planned and properly administered risk mitigation strategy is a replacement of uncertain and volatile events with a more predictable or controlled response. Risk mitigation is a continuous process and should be applied to all phases of the project.

The uncertainty of a risk event as well as the probability of occurrence or potential impact should decrease by selecting the appropriate risk mitigation strategy. Four mitigation strategy categories commonly used are:

Avoidance – when a risk is not accepted and other lower risk choices are available from several alternatives

Retention/Acceptance – when a conscious decision is made to accept the consequences should the event occur.

Control/Reduction – when a process of continually monitoring and correcting the condition on the project is used. This process involves the development of a risk reduction plan and then tracking the plan. This mitigation strategy is the most common risk management and handling technique.

Transfer/Deflect – when the risk is shared with others. Forms of sharing the risk with others include contractual shifting, performance incentives, insurance, warranties, bonds, etc.

Risks must be planned for, controlled and documented. The risk events of major relative importance to the international project are identified in the CCAC and are those that were shown to cause serious disruption on the studied projects. These elements/events are of foremost importance and need to be further addressed using a tool called a Risk Register. The intent of using the risk register is to systematically identify and track specific risks of concern that result from an IPRA assessment.

Risk response control refers to the incorporation of the risk management concepts and techniques into the project management process. Even though the project manager is responsible for developing and implementing the risk management plan by giving motivation and structure, the functional leaders must understand the implications risks have in each of their areas of responsibility. Each functional leader is significantly responsible for the execution of the risk management and control of the project.

Documentation is employed to establish a base of historical data for each facet of the risk response. A record should be kept to properly account for the status of each risk event. This historical database serves to evaluate the project as well as to build a record for future projects.

As the project progresses and changes occur, the risk events will also change from its original assessment. Therefore, the project manager must use the risk management cycle periodically to identify, analyze, handle and control those risks to lessen the uncertainty, the probability of occurrence and the potential negative impact to the project.

The Assessment, Thermometer and Risk Register generated from a CCAC assessment (and subsequent IPRA and PDRI review) provide the basis for understanding the types and relative importance of the risks associated with the project. These outputs also provide a method to track risks and mitigation action over the project's lifecycle.

Sample Project Scores

Using the CCAC, the thirteen sample projects were retroactively scored and are given in Table 9. The projects show a range of scores, with the higher the score, the more potential risk impact.

EMPLOYMENT OF RISK MANAGEMENT TOOLS FOR INTERNATIONAL PROJECTS

Because risks can arise throughout the project life cycle, risk management should be an iterative process and not limited to a one-time initial phase analysis. Given the evolving nature of risk, at critical points during the life of a project should be identified for when to use the tool. In addition, the CCAC, IPRA and PDRI tools can be used as checklists at anytime. Typically, contractors become involved in the project late in detailed scope or detailed design and are assessing when, and if, they will pursue the project. Project size, complexity and duration will help determine the optimum times when the assessment should be performed.

Table 9. Primary and Secondary CCAC for 13 sample projects

Project Number	Location	Project Type	Primary CCAC Score	Secondary CCAC Score
1	Saudi Arabia	Process/Chemical	840	200*
2	Kuwait	Oil/Water Treatment plant	440	100
3	Kuwait	Refinery	740	140
4	Qatar	Process/Chemical	620	80
5	Saudi Arabia	Process/Chemical	700	220
6	Libya	Gas Production	320	140
7	Kuwait	Refinery	700	160
8	Kuwait	Gas production	800	140
9	Malaysia	Process/Chemical	900	260
B1	Libya	Gas Production	620	320
B2	Libya	Power Plant (CC)	200	140
B3	Indonesia	Power Plant (Gas)	560	440
B4	Indonesia	Gas Processing	280	140

* projects 1 though 10 only assessed issues 1S through 3S for secondary issues

Figure 3 illustrates two potential scenarios where this assessment could be useful. This diagram shows the typical life cycle of a project, with the diamonds representing phase gates into the next phase of the project. For instance, if the contractor is bidding on an engineer/ procure/ construct (EPC) contract, it will be assessing the project during the detailed scope phase of the project. It will probably want to perform a rough assessment (1a) and then if the project risks seem acceptable, perform a more detailed assessment prior to submitting a bid package (1b & c). Similarly, if the project is for construction alone, the contractor would assess the risk during detailed design as illustrated by 2a and 2b & c. Once the work progresses (i.e., the contract is signed), the IPRA and PDRI assessments should be used to help manage risks during execution.

The structure could be similar to the diagrams shown in Figure 3 (Step 1a/2a, then Step 1b&c/2b&c analysis) and then followed by detailed follow-up as given in Figure 6.3.

The CCAC would be applied at the rough assessment in Figure 3. If the project team decides to move forward, it may use the full IPRA and PDRI tools as checklists for a rough evaluation (step b.). The process shown in Figure 4 could be a legitimate way for this to happen (step c.) using the IPRA and also the PDRI.

Assessing project risks should be done as early as possible during project development. However, the earlier the risk assessment is performed typically less project information is available. The optimal value of the IPRA is obtained when used before initiation of contract documents, however it can be used at varying times during the project's life cycle.

The CCAC, IPRA (and PDRI) are best used as tools to help project participants facilitate risk identification and determine their relative importance. Elements should be evaluated individually and scored before moving to the next. If action needs to be taken on an element, these should be recorded and tracked as action items.

Potential IPRA / PDRI Contractor Application Points

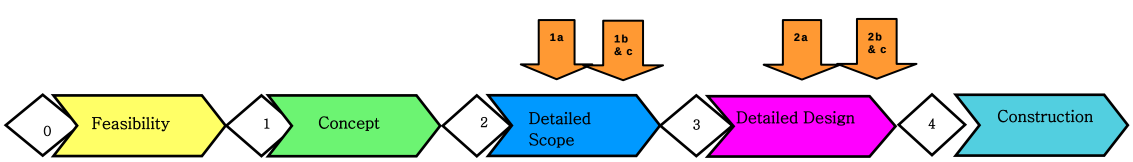

Figure 3. Employing the IPRA/PDRI, Application Points

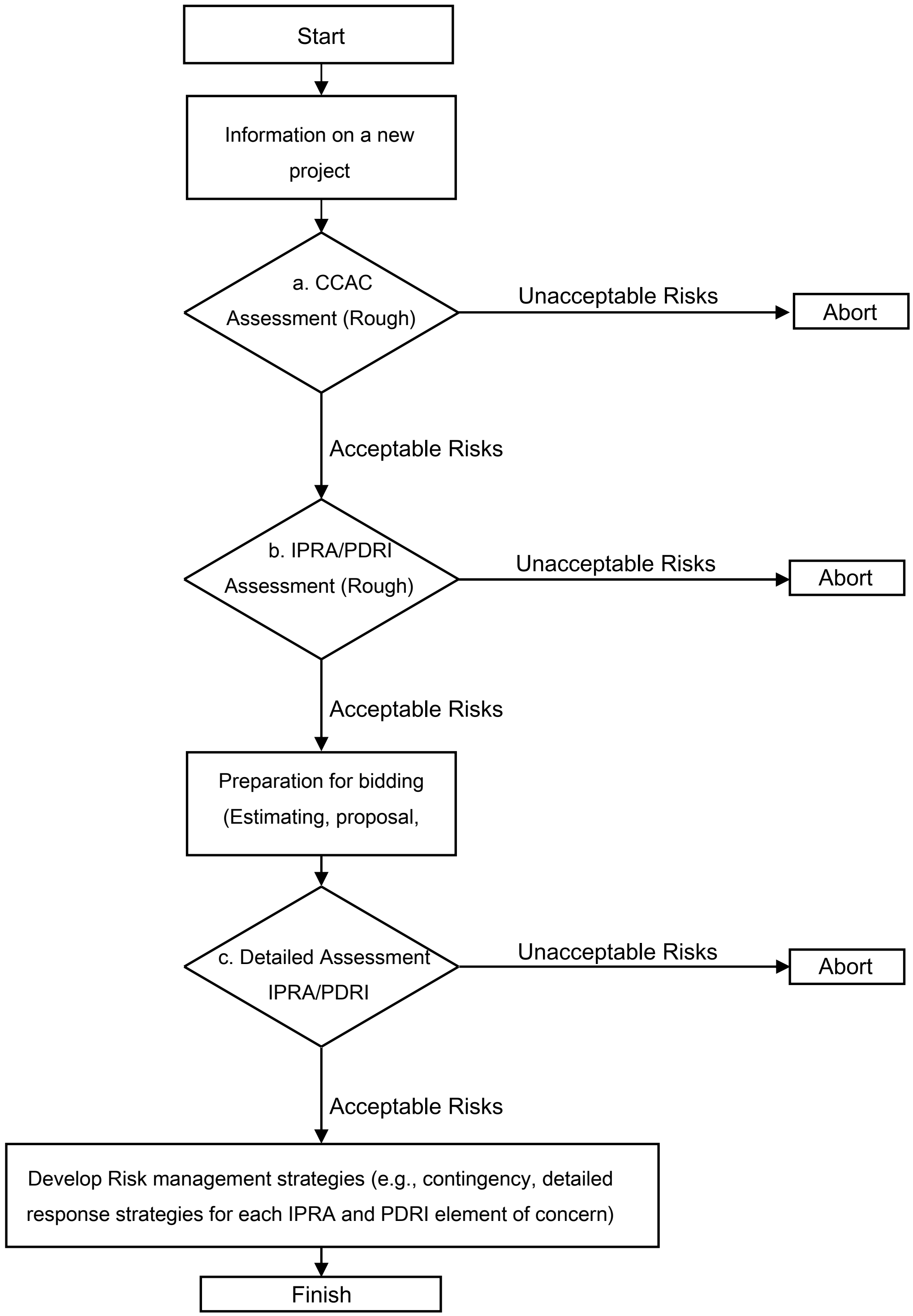

Figure 4. Flowchart of a Potential Modified CCAC/IPRA/PDRI Process

OPPORTUNITIES TO ENHANCE PROJECT DELIVERY PROCESS

Each organization studied appears to have procedures to properly manage risks once they have been identified. However, the current workload combined with the evolving nature of Middle East plant projects require a much more proactive method to systematically identify and assess risks to meet the investment goals and objectives, scope, schedule, and costs.

The IPRA process is focused on identifying and understanding the risks associated with international capital facilities for both contractors and owners and does not attempt to be a comprehensive inventory and assessment of all project risks. Therefore, a customized process for Korean contractors may provide the largest payoff.

Each of the review teams emphasized the importance of managing project risks from the point of view of their respective organizations, and most were in agreement that a standardized process could benefit their organizations. Furthermore, a standardized process of identifying, assessing, and benchmarking the likelihood and impact of individual risks over the life cycle of a project could help establish a more quantitative approach to the IPRA.

Significant lessons should be drawn from the collective experiences of Korean contractors and the staff who manage their Middle Eastern oil and gas projects. The complexity of planning, designing and constructing international projects requires a vigilant effort to identify, assess and mitigate the evolving nature of the risks that are currently known as well as those that will emerge as the project moves forward. Given the need to integrate requirements across the project, it is important to take a more proactive approach to developing a risk register and integrate this into the planning process for each project. One way to make this happen would be to use the IPRA and PDRI tools in a charrette including key personnel to ensure that risks are identified, tracked and mitigated as the project proceeds. Alignment would be promoted and a smoother transition could occur between offices.

The CCAC was developed based on the input of 13 heavy industrial projects performed by Korean contractors. In sum, these projects were worth hundreds of millions of U.S. dollars. This tool should be used as a first screening by Korean contractors who are pursuing international oil and gas projects.

The IPRA used in conjunction with the PDRI could be beneficial in developing a framework to assess and validate risks as well as procedural step to further quantify how risk impacts and likelihood affect project cost and schedule.

The owner's perspective on projects is an important factor that influences design and construction. Knowledge of the jurisdiction, to include workforce and construction methods is also very important. Contractors working outside of their home jurisdiction should consider detailed constructability reviews with both owners and subcontractors for each project.

The IPRA tool can be used in a post-mortem capacity to understand risks and translate lessons-learned into the capital investment process. To effectively capture this information, the cost and schedule impacts of individual risk elements need to be captured to evaluate the effectiveness of mitigation strategies.

A risk management process using the IPRA can greatly help with project phase transitions from initiation to occupancy. The IPRA can help project participants better understand issues that need to be worked.

RECOMMENDATIONS

Korean contractors recognize the importance of managing project risks and are attempting to improve risk identification and assessment practices. Whereas, risk management is occurring effectively on some projects, the lack of a formal risk management process for the life cycle of the project makes it more likely that risks will be viewed as components of the project that cannot be managed.

As part of this investigation effort, the IPRA elements were rewritten to focus more on issues facing Korean contractors. The research team recommends that a formal, detailed risk assessment should occur *at least* once prior to contract signature and should involve key project participants from each of the project phases including cost estimating, planning, design, procurement, legal, acquisitions, and construction. The risk management process should begin in the Initiation phase of the project and carry forward into construction. This formal assessment will provide two major benefits. First, it will ensure that most important risk issues are identified, measured and mitigation planned. Second, it will significantly improve communication and coordination among project participants as the project moves from initiation to transfer to the owner organization.

A risk register (RR) should be developed using the CCAC, IPRA and PDRI at the earliest stages of the project. The RR can then be used to pursue actions to mitigate risk, such as transferring risk to contractors, insuring risks, designing technical solutions, or taking management actions including adjusting the management reserve either up or down. The RR provides an excellent avenue to communicate issues that need to be addressed, as a transition between the project phases and as input to the cost estimating function, design function, and procurement function.

We also recommend that contractors should seek more involvement with owner organizations and in-country sub-contractors as early as possible in the project development process to allow for adequate risk allocation between all the parties associate with the project.

ACKNOWLEDGEMENT

The financial support from the Korean Ministry of Construction is acknowledged. The research team would also like to thank the participants from the Hyundai Institute of Construction Technology who provided their expertise and guidance throughout this research. The writers would also like to thank the representatives from the Korean construction firms who directly contributed to the researcher's data collection effort.

REFERENCES

Construction Industry Institute. 2006. Development of the Project Definition Rating Index (PDRI) for Building Projects. Implementation Resource 155-2, 2nd Edition. Austin, TX.

Construction Industry Institute. 2006. Development of the Project Definition Rating Index (PDRI) for Industrial Projects. Implementation Resource 113-2, 2nd Edition. Austin, TX.

Construction Industry Institute. 2003. Risk Assessment for International Projects. Implementation Resource 181-2. Authored by CII Project Team 181. Austin, TX.

Construction Industry Institute. 2003. Risk Assessment for International Projects. Research Report 181-11. Authored by John Walewski and G. Edward Gibson, Jr. Austin, Texas.

Construction Industry Institute. 2003. Risk Assessment for International Projects: A Management Approach. Research Summary 181-1. Austin, Texas.

Construction Industry Institute. 1988. Risk Management in Capital Projects. CII Source Document 41. Authored by James Diekmann, Edward Sewester, and Khalid Taher.

Gibson, G. E., Walewski, J., Kim, S., Ingam, C., and Hajian, H. 2007. Middle East Plant Projects: Programmatic and Project-level Risks, Phase II Report to the Hyundai Institute of Construction Technology, November 20.

Gibson, G. E., Walewski, J. and Kim, S. 2006. Middle East Plant Projects: Programmatic and Project-level Risks, Existing Systems Report (Phase I) to the Hyundai Institute of Construction Technology, September 14

Han S, Diekmann J. 2001. Approaches for making risk-based go/no-go decision for international projects. *ASCE J Construct Eng Manag* 127(4):300–308.

Walewski, J. 2005. International Project Risk Assessment. Doctoral Dissertation. The University of Texas at Austin.

Walewski, J., Gibson, G., and Dudley, G. 2003. Risk Assessment for International Construction. Research Report to the Construction Industry Institute, Research Report 181-11. The University of Texas at Austin.