POTENTIAL RISKS IN CIVIL INFRASTRUCTURE PROJECTS IN EGYPT

Karim El-Dash[(1)] and Mohamed Abdel Monem[(2)]

(1) Assistant Professor, College of Technological Studies, Kuwait, POB 42325, Shuwaikh, 70654 Kuwait, k_eldash@hotmail.com, Ph: 965-9310261, Fax: 965-5738164

(2) Teaching Assistant, Faculty of Engineering at Shobra, Egypt, 81 Shobra Street, Cairo, Egypt, m_shawky_s@hotmail.com, Ph: 20-12-3190705

ABSTRACT

Infrastructure construction projects are typically large, uncertain, and complex. They are subject to more risks related to economical, social, political, and environmental conditions than other types of construction projects. The aim of this study is to identify and analyze the most common risks that affect civil infrastructure projects in Egypt. The study includes the identification of the major common potential sources of risk for the civil infrastructure projects in Egypt. It extends to include an analysis for the probability and impact of these potentials on large construction projects.

The study was based upon a questionnaire that was conducted among many practitioners working in the major civil infrastructure projects in Egypt. In order to identify the degree of impact of each risk event, and rank all risks according to their degree of impact and index score, a questionnaire comprises of 49 risk sources was utilized. Risk sources were divided into four categories; (1) macro or (country), (2) market, (3) construction project, and (4) operation level. Market level was divided into six subgroups; technology, contract, resources, quality, financing, and construction and cultural. Construction project level was divided into seven subgroups; technology, contract and legal issue, resources, design, quality, financial, and construction and cultural indicators. A statistical analysis was conducted using the data collected from the construction practitioners to measure and illustrate the effect of the considered parameters.

INTRODUCTION

Infrastructure construction projects are typically large, uncertain, and complex in many aspects. Therefore, they are subject to more risks related to economical, social, political, and environmental conditions than other types of construction projects. Should these risks materialize, they may have an impact on the cost, schedule, and/or quality of projects (Chapman and Ward; 1997, Grey; 1995, and Rafftery; 1994). Construction risk can seldom be eliminated. In order to prevent unexpected risks and thus disputes during construction, international contracts should pay close attention to local project characteristics and contract practices. Demand for efficiency of massive infrastructure development has forced developing countries to open their construction markets. Emerging large-scale international construction companies frequently challenge the fairness of government contracts for civil engineering projects. These, combined with the impact of the General

Agreement on Trade in Services (GATS) on changing construction-related regulations, will cause changes in the environment of the construction industry in many countries as well as influence the contract strategies for future infrastructure projects. International competitive bidding procedures will be the standard practice; then, government agencies will be subject to much stronger pressure from the international construction industry to prepare fair construction contracts. This situation imposes the bad need for the implementation of risk management approach in infrastructure projects (Edwards; 1995, Smith; 1999, Thompson and Perry; 1992, Lam; 1999, Grimsey and Lewis; 2002, and Millar and Lessard; 2001).

OBJECTIVES OF THE STUDY

The aim of this study is to identify and categorize the most common risks that affect infrastructure projects in Egypt. It is also aimed in this study to deduce a risk significance index that shows the relative significance of these risks. Moreover, it is targeted to rank these risks based on the introduced index scores providing a useful reference to practitioners and investors to consider these major risks. This study is based upon a questionnaire that was conducted by the investigators among many practitioners working in the major infrastructure civil projects in Egypt.

QUESTIONNAIRE

In order to identify the degree of impact of each risk event, and rank all risks according to their degree of impact and index score, a questionnaire comprises of 49 risk sources was utilized. Risk sources were divided into four categories; (1) Macro or (country), (2) Market, (3) Construction project, and (4) Operation level (Hastak and Shaked; 2000).

As shown in Table (1), the first category involves six risk sources, which are considered the most common risk sources at country level that affect most of the projects in the country regardless of the application area of the project. The second category includes the risks which are common for construction projects in general. These sources are labor and equipment availability and productivity. Also quality and availability of local contractor and materials as well as finance and contract type were included. The third category lists the risk sources affecting the executing stage of the construction project. Such as delay of payment in contract, delay in approvals and design, defective design and rework. Fourth category includes the risk sources affecting the operation processes of the project. Such as demand, supply, technical and associated infrastructure risks. The third and fourth categories include the potential risks that concern the considered project specifically.

The risk management of infrastructure projects is targeted in this study to investigate the effect of various risk sources on financing the project, primarily. Moreover, the impact of risk management on any individual process in the project is considered, too. The study considered the effect of risk sources on the project duration and quality as well.

QUANTIFICATION OF RISK

The main purpose of this survey was to analyze the relative significance among the risks identified and to highlight the major risks. In this study, the risk qualitative analysis was carried out for the questionnaire results by defining a degree of severity factor (α) for each risk source as illustrated in the following session (Ezell et al.; 2000, Mohamed and McCowan; 2001, and Shen et al.; 2001).

The respondents were requested to judge the severity of each risk. There were many criteria that respondents needed to consider. These criteria included the degree of impact or the level of gain/loss if the risk occurs whether affecting cost, time, or function of the task itself or the project as whole. The impact level was categorized into five levels, namely; “very low”, “low”, “moderate”, “high” and “very high risk”. Therefore, risk significance, R_S, can be described in the following form:

$$\mathbf{R_S = \mathit{f}\ (\alpha, \mathit{N})} \qquad \mathbf{(1)}$$

where: α Degree of impact which one of the five levels as mention previous.
N No. of respondents for each degree of impact of this risk.

The variable, N, comprises of five levels where N_1 is number of respondents who answered “very low”; N_2 is number of respondents who answered “low”; N_3 is number of respondents who answered “moderate”; N_4 is number of respondents who answered “high”; N_5 is number of respondents who answered “very high”.

ANALYSIS OF SURVEY RESULTS

In order to assess the relative significance among risks, it was suggested in this study to establish a risk significance index by calculating a significance score for each risk. The importance of this significance index is to provide a useful reference to help managers and investors to consider these major risks. One of the proposed alternative procedures for calculating the significance score is to multiply the degree of impact (α) by number of respondents for each risk (N). Thus, the significance score for each risk can be obtained as follows;

$$\mathbf{\mathit{S}_{ij} = \alpha_{ij} \times N_i} \qquad \mathbf{(2)}$$

where: S_{ij} Significance score for risk, *i,* assessed by respondent j
α_{ij} Degree of impact for risk, *i,* assessed by respondent j
N_i No. of respondents for each degree of impact of risk, *i*.

By averaging scores from all responses, it was possible to get an average significance score for each risk. This average score is called the “risk index score” and is used to rank each risk event among all risks. The equation for calculating risk index score can be written as;

$$RS = \frac{\sum_{j=1}^{n} S_{ij}}{n} \quad \textbf{(3)}$$

where: R_S is an index score of risk, *i,*
S_{ij} is significance score assessed by respondent, *j*, for risk, *i*,
n is number of respondents.

In order to calculate S_{ij}, there is five-point scale (very low, low, medium, high, and very high) need to be converted into numerical scale as an alternative quantitative mean. It was suggested that “very low” assigned a value of 0.1, and “low” assigned a value of 0.25, and “medium” assigned a value of 0.5, and “high” assigned a value of 0.75, and “very high" assigned a value of 1.0.

Hence, Equation (3) can be rewritten as;

$$RS = \frac{(0.1N_1 + 0.25N_2 + 0.5N_3 + 0.75N_4 + 1.0N_5)}{(N_1 + N_2 + N_3 + N_4 + N_5)} \quad \textbf{(4)}$$

Upon the application of the responses to Equations (2) and Equation (4), the index scores are calculated for all risks as shown in Table (1). Calculation of level of risk importance for each risk is performed by transforming all responses into percentage and calculating level of risk importance, accordingly. Risk importance is assigned according to the category of the maximum percentage among the five categories of each risk.

Table (1) Analysis of Risks Associated with Infrastructure Projects in Egypt (Questionnaire results)

No.	Risk Description			Severity					Level of Risk Importance	Index Score
				Very Low	Low	Mode-rate	High	Very high		
1	Macro		Monetary Inflation	9%	11%	41%	23%	16%	Moderate	0.572
2			Economic Growth	7%	21%	28%	30%	14%	High	0.565
3			Communication and Transportation	16%	14%	30%	34%	7%	High	0.522
4			Professional Services Other Than Construction	16%	18%	36%	25%	5%	Moderate	0.476
5			**Capital Flow**	9%	16%	16%	21%	37%	Very High	**0.660**
6			Sources of Revenue and Major Spending	7%	23%	26%	28%	16%	High	0.565
7	Market	Technology	Market Suitability for Advanced Technology	16%	18%	43%	20%	2%	Moderate	0.453
8			Availability of' Basic Construction/Technology and Equipment	11%	27%	23%	30%	9%	High	0.506
9		Contract	Types of Partnerships	28%	12%	33%	21%	7%	Moderate	0.447
10			Types of Contracts	19%	16%	23%	30%	12%	High	0.519
11			Procedure for Bidding and Design Approvals	16%	25%	27%	30%	2%	High	0.459
12		Resource	Availability and Quality of Local Contractor	14%	34%	11%	27%	14%	Low	0.497
13			Availability of Construction	19%	21%	19%	26%	16%	High	0.519

Table (1) Analysis of Risks Associated with Infrastructure Projects in Egypt (Questionnaire results)

No.			Risk Description	Severity					Level of Risk Importance	Index Score
				Very Low	Low	Mode-rate	High	Very high		
			Material							
14			Availability of Skilled and Unskilled Workers	14%	27%	18%	27%	14%	Moderate	0.514
15			Equipment Cost/Productivity	5%	30%	26%	26%	14%	Low	0.540
16			Labor Cost/Productivity	7%	30%	30%	23%	9%	Moderate	0.501
17			Availability of Equipment and Parts	14%	23%	19%	26%	19%	High	0.543
18		Quality	Quality of Work	11%	16%	23%	36%	14%	High	0.574
19		Financing	**Medium and Long Term Financing**	2%	14%	21%	44%	19%	High	**0.659**
20			Tax and Non-Tax Incentive in Construction Industry	5%	23%	27%	36%	9%	High	0.561
21		Culture	**A/E/C Firms, Client and Owner Relationship**	7%	16%	30%	26%	21%	Moderate	**0.600**
22			Competitive/Negotiated Bidding	7%	14%	56%	19%	5%	Moderate	0.507
23	Project	Technology	Problems in Technology Transfer and Implementation	20%	23%	32%	25%	0%	Moderate	0.424
24		Contracts	Possibility of Contractual Dispute	9%	32%	20%	27%	11%	Low	0.509
25			**Delayed Payment in Contract**	5%	16%	20%	32%	27%	High	**0.658**
26			Problems in Dispute Settlement	14%	19%	30%	28%	9%	Moderate	0.514
27		Resources	Labor Disputes	27%	32%	23%	16%	2%	Low	0.363
28			Shortage of Skilled and Unskilled Workers	19%	30%	23%	16%	12%	Low	0.449
29			Availability of Special Equipment	16%	20%	34%	18%	11%	Moderate	0.488
30			Delays in Material Supply	9%	26%	14%	35%	16%	High	0.567
31		Design	Delay in Design and Regulatory Approvals	11%	14%	27%	34%	14%	High	0.574
32			**Defective Design. Error, and Rework**	16%	11%	14%	39%	20%	High	**0.607**
33			Actual Quantities of Work	19%	12%	35%	30%	5%	Moderate	0.495
34			Work Change Order	18%	18%	20%	39%	5%	High	0.501
35			Difficulties to Meet Construction Programs	7%	20%	32%	32%	9%	High	0.547
36			Unforeseen Adverse Ground Conditions	20%	14%	23%	32%	11%	High	0.520
37		Quality	Bad Quality of Materials	16%	39%	16%	18%	11%	Low	0.442
38		Financing	Financing Difficulties Because of Tax or Capital Movement Restrictions	16%	25%	14%	36%	9%	High	0.510
39			Drop in Project Revenue	11%	20%	23%	30%	16%	High	0.557

Table (1) Analysis of Risks Associated with Infrastructure Projects in Egypt (Questionnaire results)

No.		Risk Description	Severity					Level of Risk Importance	Index Score
			Very Low	Low	Mode-rate	High	Very high		
40		Difficulty in Converting Local Currency to Foreign Exchange.	28%	21%	7%	26%	19%	Very Low	0.493
41	Culture	**Construction Manager**	14%	11%	18%	36%	20%	High	**0.610**
42	Culture	Third Party Delays	14%	14%	37%	23%	12%	Moderate	0.526
43	Culture	Accident and Safety	7%	32%	32%	27%	2%	Moderate	0.473
44	Culture	Weather Conditions and Other Natural Causes of Delay	20%	34%	32%	11%	2%	Low	0.373
45	Culture	Physical Damage to Project by Riots, Terrorist, and Acts of God	41%	25%	25%	7%	2%	Very Low	0.302
46	Operation	Associated Infrastructure Risks	14%	20%	36%	25%	5%	Moderate	0.480
47	Operation	Technical Risks	18%	32%	30%	20%	0%	Low	0.399
48	Operation	Demand Risks	20%	20%	34%	20%	5%	Moderate	0.441
49	Operation	Supply Risks	23%	27%	23%	25%	2%	Low	0.414

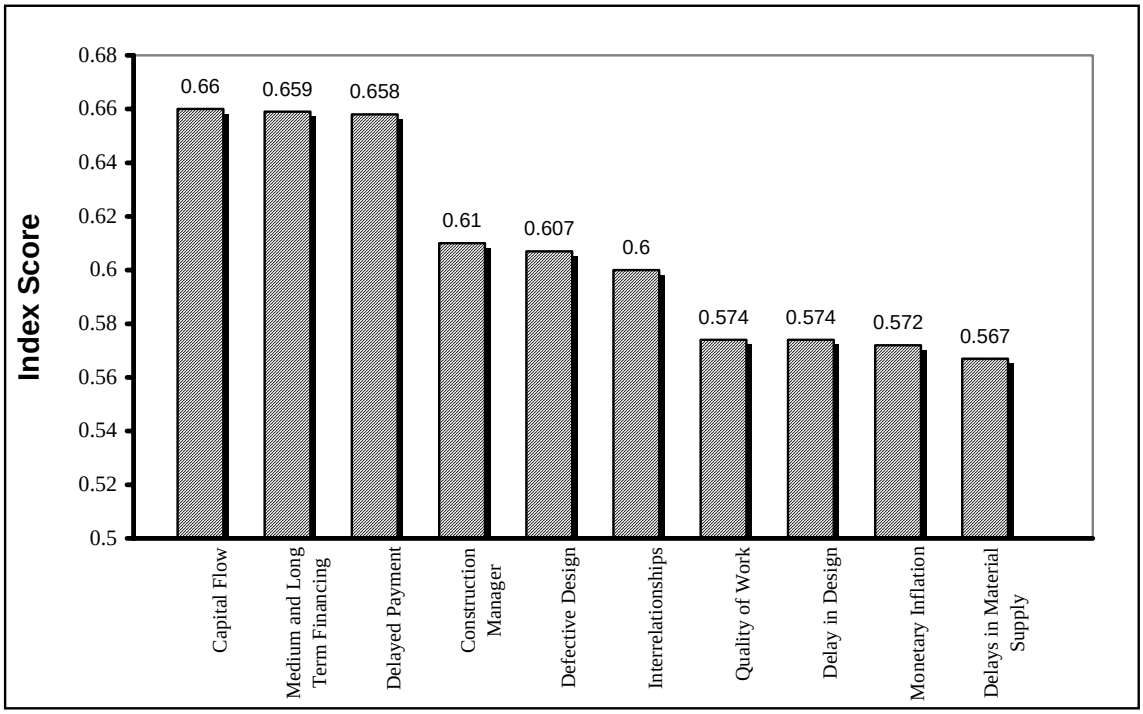

Figure (1) Major potential risk sources for infrastructure projects in Egypt

The results presented in Table (1) and Figure (1) shows that there is a set of three sources of risk which is at the top of the list. The first of these three is the capital flow that controls the progress of the project. Investors are willing to provide capital for a project only if they believe that there a high possibility to obtain adequate returns. Therefore, the owner must include compensation for the expected level of risks during the investment period. The second source of risk is the long term financing which is dependent on the allocated budget mainly from the government. Medium and long term financing represents a great risk that intimidates most of large projects and infrastructure projects. Since a large project requires significant amount of funds

for day-to-day operations, investors and owners must study the project requirements for long-term operating and maintenance financing. The third source of risk in this set is the delayed payment which is related to government as well as private sector.

There is a second set in rank that includes other three sources of risk. These three are the efficiency of the project manager based on his knowledge and skills, the rework that results from defective or shortage in design drawings or specifications, and the interrelationship among A/E/C firms, client, and owner which is a major cultural problem in the developing countries.

The third set of potential risk sources that commonly affect infrastructure projects includes four sources. The first is the quality of work that still contributes a lot to the projects in the developing countries in general where the concept of quality is not settled yet. The next source is the delay that may result from the unfinished design drawings and specifications or may be due to obstacles in the permits' requirement. The third is monetary inflation that depends on the strength of the economy of the country. Since the economy of Egypt has been struggling for the last five years, all infrastructure projects are drastically affected by this parameter. The last source of risk in the list of the top ten is the probable delay in material supply that usually results from poor procurement and expediting system. This delay sometimes is referred to the changes in the regulations for importing materials or due to changes in the prices and rates of exchange.

SUMMARY AND CONCLUSIONS

Civil infrastructure projects comprise high risk that may affect the execution of the project. A questionnaire was conducted to identify and analyze the major common potential risks that may affect infrastructure projects in Egypt. The results of the collected data and the implemented analysis showed that:

- Major potential risks are:
  a- Capital flow,
  b- Long term financing,
  c- Delayed payments,
  d- Construction manager,
  e- Defective design and rework, and
  f- A/E/C firm, client, and owner relationship.
- The major risks are dependant on the economy status of the country affects cash flow, inflation rates, contract payments for governmental as well as private sector, and long-term financing.
- The cultural behavior of the stakeholders has a major role in the execution of the project since it affects the interrelationship among the stakeholder. The shared benefit of the project still hiding behind the individual benefits of the stakeholders which reduce the efficiency of the project performance.
- The awareness, knowledge, and skills of the project management still below the required level especially for large scale project like infrastructure projects. More awareness and training is needed in this regard. Most of the problems

experienced through delay of design and permits, delay of material supply, or defective design and rework are related to poor managerial performance.

- Quality of the performed work is one of the main issues that comprise risk for the success of infrastructure projects. The problem of quality rises from the weak implementation of the specifications and the contract terms such as contractors' penalty for performance lower than specified.

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