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Identifying the Significant Risk Management Factors for Construction of Public Projects in Jordan

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Abstract: *The aim of the current study is to identify and assess the most significant risk factors affecting the construction of public projects in Jordan and their probability of occurrence, impact and total effect. A questionnaire survey was carried out and a total of 53 risk factors were identified and categorized into four groups. These are technical related (19 factors), management related (12 factors), financial and market related (13 factors) and political, social and environmental related (9 factors). Total number of participants contributed to the survey was 108 distributed as 36 clients, 32 consultants and 40 contractors involve in the implementation of public works projects. The results are presented on the basis of probability of occurrence, impact and total effect. Number of factors that showed significant effect on the performance of the projects is: eight factors are related to technical group; six factors are related to management group; five factors are related to financial and market group and four factors are due to political, social and environmental factors. Total of 20 out of 53risk factors showed that they are of significant effect. Top ten factors of significant effect on risk in public sector's projects in Jordan are: (1) Changes of design by different parties, (2) Management problems related to the contractors, (3) Design and contract documents errors, (4) Conflict in contract documents, (5) Lack of planning and budgeting of project, (6) Financial problems suffered by contractors , (7) Inappropriate communications between client and other parties, (8) Loss due to bureaucracy and late approval, (9) Material wastage on site (10) Rework due to labor mistakes.*

Keywords: *Risk factors, management, construction project, public works, Jordan*

I. Introduction

Risk management is one of the nine knowledge areas covered by the project management Institute [1]. The advantage of implementing risk management process will be identifying and analyzing risks and improvement of construction projectactivities and optimum usage of resources. Construction projects are always unique implemented and risks occurred due many different reasons [2].

The construction projects are complex and dynamic. This is due to multiple feedback processes, so many participants are involved with different experience and interests [3].

Risk management assists the participants involved in the construction process (Client, Consultant, Contractors and other parties) to meet their obligations and reduce the negative impact on the performance of the project management represented by time, cost and quality.

The construction projects in Jordan, in general, and public projects in specific, experience different kinds of risks through the different phases of the project. Most of these projects do not carry any risk prediction during the tendering phase. The risk in construction should be realized as incident that affects the project goals and in specific cost, time and quality. Some of the risks related to construction activities can be predicted reasonably while the others cannot [4].

As far as project management is concerned, the most important effects of risks are:

- The possibility of not finishing the project within the cost estimate.
- The possibility of not completing the project within the expected time.
- Not achieving the required quality and operational requirements.

1.1. Definition and context of risk management

The term "risk management" in construction projects relates to recognizing, analyzing and responding to the risk of the project.

The risk management comprises the maximizing of the output of favorable activities and reducing the effect of adverse activities [5].

British standard institute defines risk as "the uncertainty implicit in plans and potential of something occurred that can influence the likelihood of achieving, business or project aim [6]. In a project status, it is a chance of an activity or action occurs that will have an effect upon aims. It includes the probability of loss or winning, or diversion from the expected or planned outcomes, as a result of the uncertainty linked with

following a certain course of action. Accordingly risk has two elements. These are the chance or likelihood of an action occurring and the results or influence of it does.

Risk management is an integral part of successful management, and essential to achieving successful business and project outcomes and successful procurement of goods and services. Risk management presents a clear way of appreciating and handling future uncertainty.

1.2. Classification of risk

There are different ways for sorting risk for different objectives. [1] classifies risks in construction projects, in general, in to external risks and internal risks. Other authors, like [7] categorize risk in greater detailed items. These are political risk, financial risk, market risk, intellectual property risk, social risk, safety risk, etc. [8] suggested that the type risk, rely upon whether the risk is national or international. The internal risks are related to all projects regardless of whether they are national or international projects.

II. Objective of the Study

The objectives of this study can be summarized as in the following:

- Recognizing and categorizing the risk for public construction projects in Jordan.
- Using probability, impact and total effect to rank the factors causing risk in Jordanian public construction projects.

III. Literature Review

The risk in project management is well known as one of the most crucial process and potency areas in the field of project management. Some of the research works in the field of risk management are shown below.

Reference [9] classified the factors causing risks into 8 groups. In their survey about risk management, [10] concentrated on Build-Operate-Transfer (BOT) projects in china and discussed, in specific, the criticality of the political and force majeure risks. Reference [11] developed a model in a formal way to take into consideration and quantifying uncertainty in the plan of construction project.

In Russia, the risk management of global and joint venture construction with foreign cooperation was studied by [7]. Similar study by [12] considered the risk factors associated with financial aspects related to international construction from incorporated point of view.

In Hong Kong, reference [13] studied the importance of risk factors to the building contractors. In Queensland, [14] carried out a survey involved senior construction management. This survey was related to the utilization of risk management techniques.

Reference [15] in their study which was based on questionnaire survey identified that contractors suffer more from contractual- related and legal- rated risks rather than the other types of risks.

In United Kingdom, as developed country, [16] carried out a survey to examine the priorities in the allocation of risk. The analysis of data collected from the questionnaire revealed that some risks should be possess in the public sector or participated with private sector.

Methodology Followed In This Study

The study followed the steps described below to achieve the objectives:

1. Literature review concerning the risk management in construction projects. The review concentrated on identifying the risk factors that affect the performance of construction projects.
2. Relying on the literature review, a questionnaire set was created. The questionnaire consists of two parts. The first has the general questions about the engineers who responded to the survey such as the establishment type, years of experience, value of projects they are responsible for, etc. The second part of the questionnaire contained questions about the evaluation of construction risk. In this study, (53) risk factors are considered, distributed into (4) categories. These are technical related factors (19 factors), management related factors (12 factors), financial and market factors (13 factors) and political, social and environment factors (9 factors). Likert scale of 1 to 5 was utilized in this questionnaire. The respondents were asked to estimate the total risk effect of each risk factor. The approach considered is to have two features for each risk: the expected probability level of the risk occurrence represented by Probability Index (P.I) and the degree of impact or the level of loss if the risk occurs represented by Impact Index (I.I).By applying this approach, the respondents were asked to respond to the two attributes for each risk factor. For considering (P.I), the respondents were required to estimate the probability level of risk occurrence by selecting one from among five levels, namely: Very small, Small, Normal, large, and Very Large. For considering (I.I) the respondents were asked to estimate the degree of impact if the risk concerned occurs by selecting one from among five grades, namely: Very low, Low, medium, High, and Very high.

3. Carrying out many construction projects sites visits in different cities in Jordan (Amman, Zarqa, Irbid and Aqaba).
4. Distributing the questionnaire and personal interviews with key staff representing the public clients.
5. Analysis of the data. This item will be discussed, thoroughly in the next section.
6. Writing up conclusions and recommendations to identify risks and suggesting remedial measures.

I. Data Analysis

Descriptive and frequency statistical analysis techniques were used to analyze the data collected in the survey. However, an advanced and accurate method is necessary to analyze the data in a systematic, fast and reliable way. For this purpose, the computer software Statistical Package for Social Science (SPSS 16) and MS Excel were selected.

The data collected from the survey were analyzed using the probability and impact index method [17] as explained below.

According to [17], a formula as shown in equation (1) was used to rank risk factors based on frequency of occurrence as identified by the participants, which is called the probability Index (P.I).

$$\text{Probability Index (P.I) (\%)} = \frac{\sum a\,(n/N)}{5} \times 100 \quad \text{----------} \quad (1)$$

Where (a) is the constant expressing weighting given to each response (ranges from 1 for very small up to 5 for very high occurrence), n is the probability of the responses, and N is the total number of responses.

Similarly, a formula as shown in equation (2) used to rank risk factors based on Impact index as indicated by the participants, which is called Impact Index (I.I).

$$\text{Impact Index (I.I) (\%)} = \frac{\sum a\,(n/N)}{5} \times 100 \quad \text{----------} \quad (2)$$

Where (**a)** is the constant expressing weighting given to each response (range from 1 for very low to 5 for very high effect), n is the frequency of the response, and N is the total number of responses.

Total Effect Index: The Total Effect index of each risk factor is calculated as a function of both probability and impact indices, as follows:

$$\text{Total Effect Index (T.I) (\%)} = \frac{\text{P.I (\%) x I.I (\%)}}{100} \quad \text{----------} \quad (3)$$

IV. Results and Discussions

6.1. Characteristics of the respondents

The respondents participated in the survey are engineers representing clients (36), consultants (32) and contractors (40). The majority of the engineers responded to the survey have experience more than 15 years. The study covered mainly the public sector projects. The respondents representing the clients are from different ministries and municipalities. The contracting companies included in the survey are only from the highest three classes (first, second and third). The respondents experience cover different types of projects (Housing, public buildings, hospitals, water supply, water treatment plants, roads, etc.). The majority of the respondents are civil engineers in addition to architectural, mechanical, electrical engineers, etc. with different qualifications (BSc. and postgraduate).

6.2. The significance of risk factors

Fifty three risk factors have been considered in this research. Rating estimation of the factors was carried out depending on the level of significance. This was estimated depending on Probability Index, Impact Index and then Total Effect Index for each factor. The 53 factors are distributed on four groups. These are: Technical (19) factors, management (12) factors, financial and market (13) factors and political, social and environmental (9) factors. The significant factors considered for each group are those with Total Effect Index above the average of the group.

6.3. Technical risk factors

The questionnaire included 19 technical-related factors. The average importance index for this group is 48.69. Fig. (1**)** shows the Importance index for each factor and the significant ones.

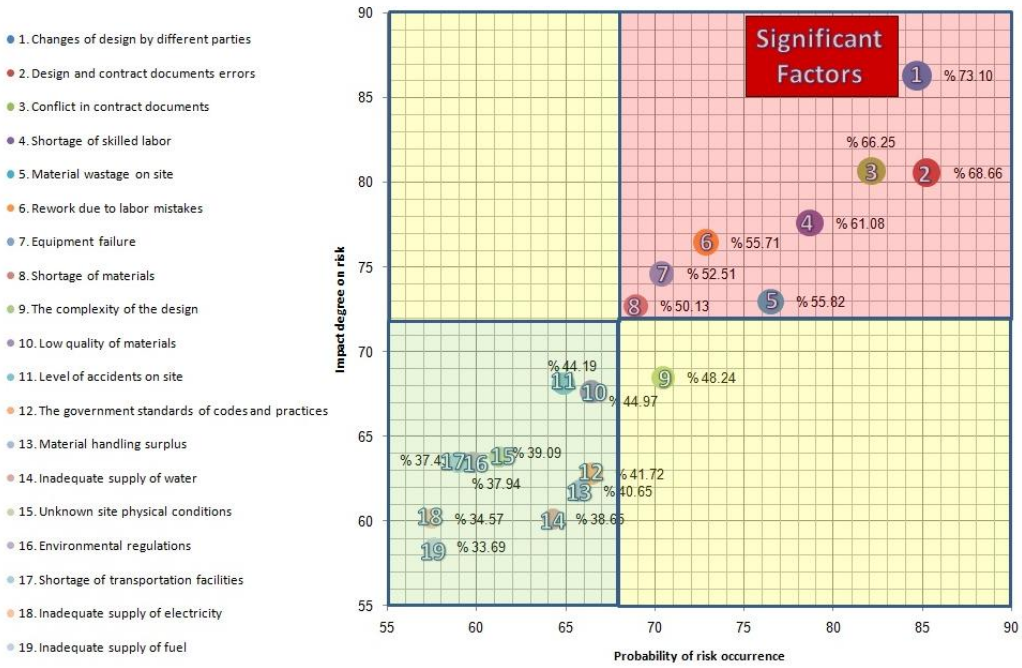

Figure (1) – The technical related risk factors

6.4. Management risk factors

The questionnaire included 12 management-related factors. The average importance index for this group is 49.05. Fig. (2) shows the Total Effect index for each factor and the significant ones.

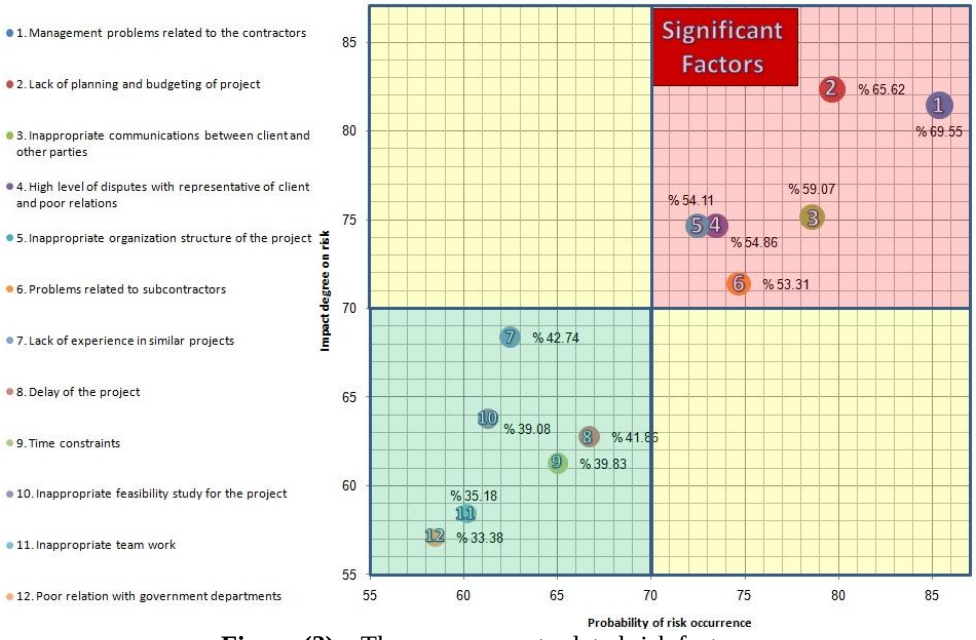

Figure (2) – The management related risk factors

6.5. Financial and market factors

The questionnaire included 13 financial and market-related factors. The average importance index for this group is 44.27. Fig. (3) shows the Total Effect for each factor and the significant ones.

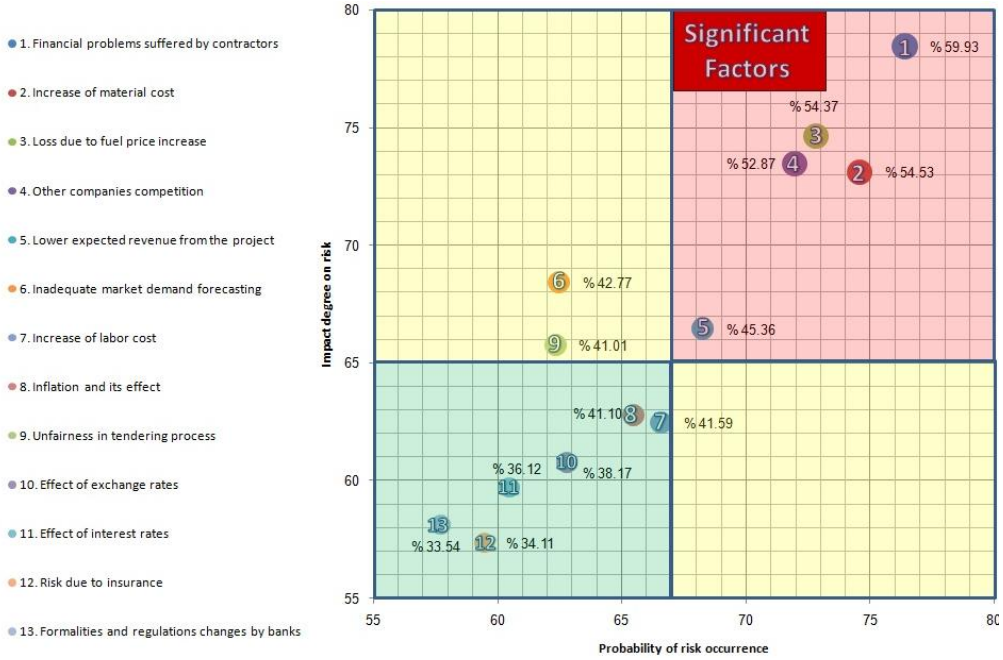

Figure (3) – The financial and market related risk factors

6.6. Political, Social and environmental related factors

The questionnaire included 9 political, social and environmental -related factors. The average importance index for this group is 43.12. Fig. (4) shows the Total Effect index for each factor and the significant ones.

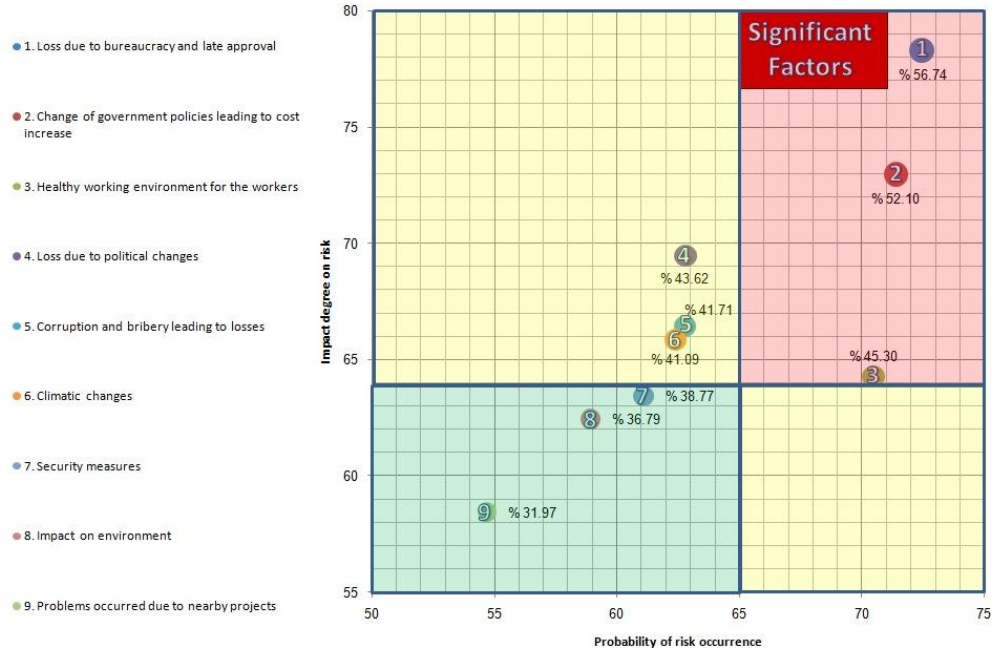

Figure (4) – The political, social and environmental related risk factors

6.7. Ranking of the most significant risk factors

While Fig. (5) shows the 53 factors considered in this study and the total effect for each factor, Table (1) below presents ranking of the most significant factors at the public construction projects revealed by the survey results presented in Fig 1, 2, 3 and 4.

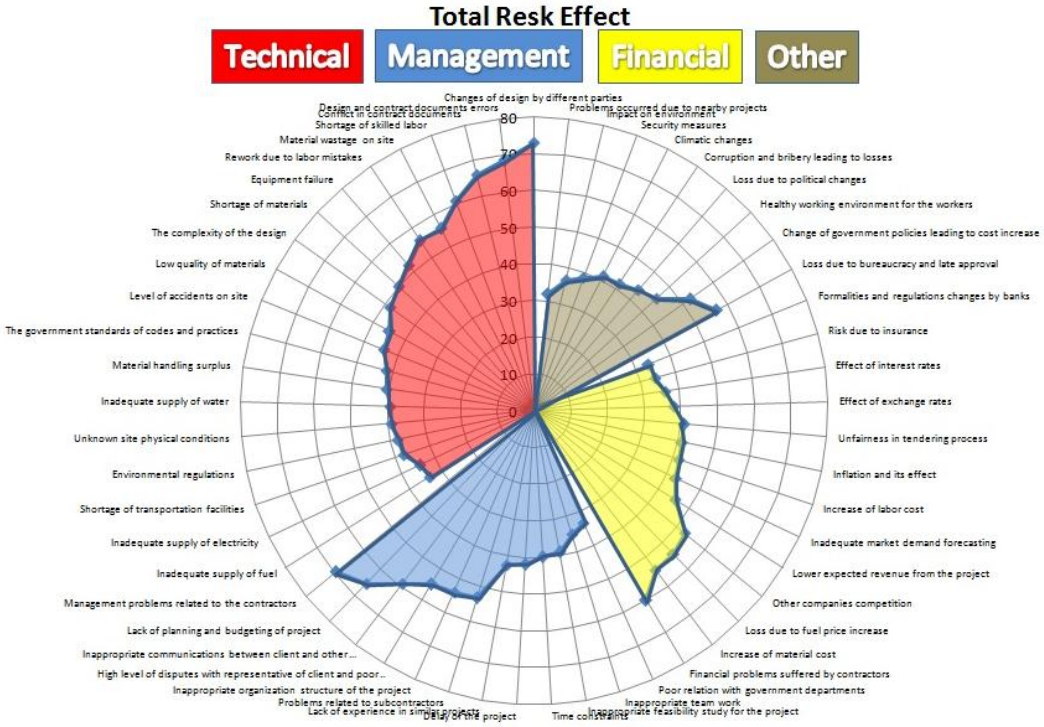

Figure (5) – The risk factors considered in the study

Table (1) Ranking of the most significant risk factors

Type of risk	Total risk effect	rank	Group
Changes of design by different parties	73.10	1	Technical
Management problems related to the contractors	69.55	2	Management
Design and contract documents errors	68.66	3	Technical
Conflict in contract documents	66.24	4	Technical
Lack of planning and budgeting of project	65.62	5	Management
Financial problems suffered by contractors	59.92	6	Financial
Inappropriate communications between client and other parties	59.06	7	Management
Loss due to bureaucracy and late approval	56.74	8	Political, Social
Material wastage on site	55.81	9	Technical
Rework due to labor mistakes	55.80	10	Technical
High level of disputes with representative of client and poor relations	54.86	11	Management
Increase of material cost	54.53	12	Financial
Loss due to fuel price increase	54.37	13	Financial
Inappropriate organization structure of the project	54.11	14	Management
Problems related to subcontractors	53.31	15	Management
Other companies competition	52.86	16	Technical
Equipment failure	52.51	17	Technical
Change of government policies leading to cost increase	52.10	18	Political, Social
Shortage of materials	50.12	19	Technical
The complexity of the design	48.24	20	Technical

Table (1) above reveals the following:

1. Among the 20 most significant risk management, there are 9 factors (45%) are related to technical risks. Next it comes the management-related group as there are 6 factors (30%) within the significant factors. In addition, there are three financial and market-related risk factors comes within the significant factors which represents (15%). In the last place comes the political, social and environmental related risk factors as there are only two factors (10%) are within the most significant factors.
2. The 10 most significant risk factors at public construction projects in Jordan are:

- Changes of design by different parties
- Management problems related to the contractors
- Design and contract documents errors
- Conflict in contract documents
- Lack of planning and budgeting of project

- Financial problems suffered by contractors
- Inappropriate communications between client and other parties
- Loss due to bureaucracy and late approval
- Material wastage on site
- Rework due to labor mistakes

6.8. Reliability of factor analysis

To examine the reliability of the factors, Cronbach's alpha (Cα) test was carried out on each group of factors to view if they were integrated. The values of Crobach's alpha should have a range between 0 and 1. The lower values represent lower internal consistency and larger values represent greater internal consistency.

The criteria introduced by [18] for the interpretation of this coefficient was considered to evaluate the results of the analysis. Cα> 0.8, 'Excellent'; 0.8> Cα> 0.7 'Good'; 0.7> Cα>0.5 'Satisfactory' and Cα <0.5 ' Poor'. Table (2) shows that the results of Cronbach alpha for all the groups.

Table (2) Reliability analysis

factors	Cronbach alpha	Result
Technical	0.765	Good
Management	0.548	Satisfactory
Financial and legal	0.479	poor
Political, social and environmental	0.638	Satisfactory
All factors	0.648	Satisfactory

V. Conclusions

The aim of the study was to recognize and categorize the risk for public construction projects in Jordan. The probability, impact and total effect were used to rank the factors causing risk in Jordanian public construction projects.

To recognize the major risk factors related to public works in Jordan. A comprehensive literature review was carried out to identify the risk factors specified in the literature. The literature review and the pilot study revealed 53risk factors distributed over four categories.

The questionnaire sets were distributed to the three main parties involve in the construction process. Number of participants responded to the survey were 36 clients, 40 contractors and 32 consultants.

Number of factors that showed significant effect on the performance of the projects is 20 distributed to: nine factors are related to technical group; six factors are related to management group; three factors are related to financial and market group and two factors are due to political, social and environmental factors.

Total of 20 out of 53 risk factors showed that they are of significant effect. Ranking of these factors was made according to the "Total Effect Indices" for the four groups.

Top ten factors causing delays for public sector projects in Jordan are: (1) Changes of design by different parties, (2) Management problems related to the contractors, (3) Design and contract documents errors, (4) Conflict in contract documents, (5) Lack of planning and budgeting of project, (6) Financial problems suffered by contractors , (7) Inappropriate communications between client and other parties, (8) Loss due to bureaucracy and late approval, (9) Material wastage on site (10) Rework due to labor mistakes.

VI. Recommendations

- Parties should compute with high accuracy and consider risks by adding a risk premium to quotation and time estimation.
- Parties should provide all the efforts to prevent financial failure by practicing a tough cash flow management and minimizing the dependence on bank loans.
- Parties should learn how to share and shift risks by hiring specialized staff or specialized subcontractors. It is suggested that the contractor enforced to employ specialized Project Management Company especially for the large scale projects to participate in both the design and construction stages.
- The contract clauses should be modified and improved to meet the impact of the political situation in the country.

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