A Study of Risk Management In Construction Industry

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I. INTRODUCTION

Project management is the science which applies skills, tools and techniques to fulfill project activities in a way that the expectations and requirements of stakeholders are fulfilled or exceeded. Project risk management is an integral part of the process which aims at identifying the potential risks associated with the project and responding to those risks. It includes activities which aim to maximize the consequences associated with positive events and to minimize the impact of negative events. It is believed generally that risk in an environment is a choice rather than luck, and the inherent uncertainty in the plans can affect the desired outcome of achieving project and business goals. Risk is present in all the activities in a project; it is only the amount which varies from one activity to another. Risks and uncertainties inherent in the construction industry are more than other industries. The process of planning, executing and maintaining all project activities is complex and time-consuming.

A. Sources of Risks:

Checklist of risk drivers:

- Commercial risk.
- Financial risk.
- Legal risks.
- Political risks.
- Social risks.
- Operational risks.
- Management risks.
- Geographical risks.
- Construction risks.
- Technological risks.
- Geotechnical risks.
- Demand/product risks.
- Environmental risks.

B. NEED AND IMPORTANCE OF RISK MANAGEMENT

Risk management is all about being able to deliver results with certainty. Risk is most often associated to the negative outbreak of an controlled uncertainty that can cause the loss of lives, money, time or quality/function. For many companies, these motives would be enough to apply risk management in their business. In the insurance business, risk is the core business and the premium is the quantification of the risk that is being insured. Depending on the profile of the insurance taker, the premium and excess vary. Business with a history of damage and mistake or individuals with a risk-prone profile, such as young male drivers, pay higher premiums due to the increased risk. As it is the core business, a great deal of interest focuses on controlling and calculating the risk in various ways in order to set the premiums at levels that make it possible to earn money. For companies taking insurance, interest in reducing the premium is based on the potential for saving money.

C. OBJECTIVE OF THE PROJECT

The risk management technique is used very less because of less knowledge and awareness among the people. The track record is also very poor in terms of coping up with risks in projects, resulting in the affection of project objectives. Risk management is adopted to contain the possible future risks proactively rather than being reactive. It applies to any project to evaluate the most, major, and common risks which cause bad effect on the construction project to achieve its objectives. The risk management concept is very less accepted technique in the civil construction industry, and then it's necessary to extend consciousness of the same.

The objectives of this study are as follows:

1. Identifying the key risk factors that could stand in front of the construction processes by Reviewing the available literature and through the additions that could be made by

the construction industry Practitioners, i.e. owners and contractors.
2. Investigating the severity and the allocation of every identified risk factor according to the perspectives of the contractors and owners.
3. Determining the risk management actions efficiency that are applied in the construction industry by each category i.e. contractors and owners.
4. Providing the practical suggestions and recommendations indicating toward the upgrading the risk management process in the construction and improve the performance of contracting companies and owners in this field.

II. LITERATURE REVIEW

A. RISK MANAGEMENT VIEWS FROM MANAGEMENT GURUS

In today's post-crisis economy, efficient risk management is a significant component of any engaging management policy. Risk management is one of the 9 knowledge areas circulated by the Project Management Institute (PMI). The Project Management Institute Guide recognizes 9 knowledge areas typical of almost all the construction projects. The 9 knowledge areas are as follows:

1) Project Integration Management.
2) Project Scope Management.
3) Project Time Management.
4) Project Cost Management.
5) Project Quality Management.
6) Project Human Resource Management.
7) Project Communications Management.
8) Project Risk Management.
9) Project Procurement Management.

Even though these knowledge areas are all equally important from a project manager's point of view, in the practice a project manager might determine the key areas which will have the greatest impact on the outcome of the project. Each PMI knowledge area in itself contains some or all of the project management processes.

For example, project risk management includes:

A. Risk Management Planning;
B. Risk Identification;
C. Qualitative Risk Analysis;
D. Quantitative Risk Analysis;
E. Risk Response Planning;
F. Risk Monitoring and Control.

Risk management is probably the most difficult aspect of project management. A project Manager must be able to recognize and identify the root causes of risks and to trace these causes through the project to their consequences. In addition, the risk management in the Construction Project Management (CPM) circumstance is a comprehensive and organized way of identifying, analyzing and responding to the risks to achieve the all project objectives. The utilization of the risk management from the early stages of a project, where major decisions such as selection of alignment and selection of the construction methodologies can be influenced, is very vital. The main advantages of the risk management procedure include the identifying and analyzing the risks and improvement of construction project management procedures and effective utilization of the resources.

The Construction activities in Lithuania provided employment to an expected 93.7 thousand persons in the year 2011, at the same time as annual earnings in excess of EURO 1.91 billion. Construction is one of the largest industries in the many countries of the world. Unluckily it has also the work-associated health and safety issues. Large number of construction industry workers are killed, injured or suffers from very serious health problems than in any other industry. In the year 2011, 13 number of construction workers killed at the same time as a construction worker, compared to the 7 other industrial workers and 4 agricultural workers.

B. RISK MANAGEMENT EXAMINATIONS FROM OTHER INTELLECTUALS AND ACADEMICIANS

The risk analysis and management techniques have been described in detail by many scientist, researchers and authors. A representative risk management process includes the following key steps those are as follows:

A. Risk Identification.
B. Risk Assessment.
C. Risk Mitigation.
D. Risk Monitoring.

The Risk identification is the very first step and possibly be the most important step in the risk management process, as it efforts to identify the source and type of the risks. It also includes the recognition of the potential risk incidents in the construction project and the clarification of the risk responsibilities. Risk identification develops for the next steps: analysis and control of the risk management.

According to S. Q. Wang and M. F. Dulami, the categorization of the risks depends chiefly upon whether the project is local or an international project. The internal risks

are appropriate to all the projects irrespective of whether they are local project or international project. International projects are liable to be subjected to the exterior risk such as lack of knowledge of the social conditions, political scenarios and economic, unidentified and new technical formalities, regulatory framework and the governing authority, etc.

According to the Project Management Institute Guide, the risks are categorized into the different groups those are as follows:

1-Technical
2-External
3-Organizational
4-Environmental or project management.

More than a few categories of risk that affects a construction activity are comparable to the risks for other asset projects, whether it's an investment in the common stocks or other government bonds, and some are the specific to the construction. Construction projects bring complex risks for all concerned—including owners, consultants, suppliers and contractors—that can boost when construction activity takes place near an active facility or overcrowded area. Risks include geological and pollution associated situations, interference with ongoing operations, construction accidents as well as design and construction faults that may harmfully impact the project both at the construction stage and after the completion of the project.

Normally two broad categories, namely:

1- Qualitative and 2- Quantitative analysis

The above categories are notable in the literatures and research papers on risk assessment. A qualitative analysis permits the key risk factors to be identified. Risk factors may be identified from end to end a data-driven (quantitative) methodology or qualitative process such as interviews of the persons, brainstorming and checklists of the various conditions. It is considered as an assessment process which involves explanation of each risk and its impacts or the one-sided classification of risk (high/medium/low) in terms of both risk impact and probability of its incidence. Qualitative risk analysis evaluates the impact and possibility of the identified risks and develops prioritized lists of the risks for further investigation or direct improvement.

Here are four alternative strategies those are as follows:-

1- Risk avoidance
2- Risk transfer
3- Risk mitigation
4- Risk acceptance.

For treating the risks in the construction project as stated by Hillson, risk mitigation and risk response development is generally the weakest element of the risk management procedure. The appropriate management of the risks needs that they be identified and owed in a well explained manner. This can only be attained if contracting parties understand their risk responsibilities, risk event conditions and risk handling capabilities.

Before the crisis condition in the year between 2004 - 2008, due to a lack of contractor's responsibilities and control in the various steps of a project development, the time and quality performance levels of construction projects in the Lithuania were generally not enough or even unfortunate. In construction projects, many different parties are involved such as owner, consultant, contractor, subcontractor and supplier. Each party has its own risks. Risk transfer means the transfer of the risk responsibility to another party either by insurance company or by contract. **Wang, 2004** reported that contractors generally use three methods to transfer risk in the construction projects:

1- Through insurance to insurance companies
2- Through subcontracting to subcontractor
3- Through modifying the contract terms and conditions to client or other parties.

Construction projects can be handled using the various risk management tools and management techniques. **Ahmed, 2001** reviewed techniques that can be used for development of the risk management tools for engineering projects. Methods for circumstance establishment, risk assessment, risk identification and treatment were provided. Application of risk management tools depends on the character of the project, organization's policy, project management approaches, risks outlook of the project, team members and availability of the resources.

Risk management is a wide and inclusive concept and doesn't just involve measurement and mitigation of risks. **Santomero (1997)** identifies four components to the Risk Management process. These are principles and reports, position limits and rules, investment strategy or strategies, and incentive contracts and compensation. Similarly, **Cumming and Hirtle (2001)** refers Risk Management to the overall process that a financial institution follows to define a business strategy and identify, quantify, understand and control the nature of risks it faces.

Many authors have evaluated problems on time performance in the construction projects. Some researchers investigated and assessed the causes of delays in the building construction

projects in Nigeria. The nine factor categories evaluated include:

1- Client 2- Contractor 3-Quantity 4-Surveyor 5- Architect 6- Structural engineer 7- Services engineer 8-Supplier and 9-Subcontractor Caused delays and external factors (i.e. delays not caused by the project participants). Finally, ten on the whole delay factors were identified, namely:

1- Contractor's financial difficulties
2- Client's cash flow problems
3- Architect's incomplete drawings
4- Subcontractor's slow mobilization
5- Equipment break down and maintenance problems
6- Suppliers; late delivery of ordered materials
7- Incomplete structural drawings
8- Contractor's planning and scheduling problems
9- Price escalation
10- Subcontractor Financial difficulties.

The authors pointed the poor risk management as one of the principal delay factors and concluded that actions and inactions of construction project participants contribute to overall project delays.

The performance by the project management team highly influences the success of a Construction project. Some of the incidental risks associated with poor project management performances are:

- Unclear or unattainable project objectives;
- Poor scoping;
- Poor estimation;
- Budget based on incomplete data;
- Contractual problems;
- Insurance problems;
- Delays;
- Quality concerns;
- Insufficient time for testing.

Ward and Chapman, 2004 concluded that stakeholders are a chief source of uncertainty in the construction projects. Chapman found that project management companies need to rise above the problems in their relationships with other professionals on the project team and through the client. For the success of the construction projects there is a need for position of the project owner's interests and the project management team's interests and trust between all of them. Construction projects are tendered and executed under different contract systems and payment methods.

III. CONCEPTION OF RISK ANALYSIS AND MANAGEMENT

The concept of risk is multi-dimensional. In the circumstance of construction industry, the chance that a definite aspect harmful to the overall project occurs is always present. A Lack of predictability associated to the consequences of a planning situation and the associated uncertainty of expected outcomes leads to the significance that results can either be better than expected or can be worse. In addition to the different definitions of risks, risks can be categorized for different purposes as well. The broad categories of construction risks are external risks and internal risks; at the same time as some other categories restrict risks as political, social and safety risk etc.

1) Project Risk:

Risk management in a project includes the identification of influencing factors which probably will harmfully impact the cost plan or worth objectives of the project, quantification of the associated impact of the potential risk and accomplishment of measures to mitigate the potential impact of the risk. The more risky the activity is, the costlier will be the consequences in case a mistaken decision is made. Appropriate estimation and analysis of risks will facilitate to decide justification of costly measures to reduce the level of risk. It can also help to decide if sharing the risk with an insurance company is justified. Some risks such as natural disasters are nearly unavoidable and affect the many people. In fact, all choices in life involve risks. Risks can't be totally avoided but with proper management these can be minimized.

2) Evaluation of Risk:

There are two methods to determine the risks in a project, specifically the qualitative and quantitative approach. The quantitative analysis depends on the statistics to calculate the chance of occurrence of risk and the impact of the risk on the project. The most ordinary way of employing quantitative analysis is to use decision tree analysis, which involves the application of probabilities to two or more outcomes. Another method is Monte Carlo simulation, which generates value from a chance distribution and other factors. The qualitative approach relies on judgments and it uses criteria to determine outcome. A general qualitative approach is the priority diagramming method, which uses ordinal numbers to determine priorities and outcomes. Another way of employing qualitative approach is to make a list of the processes of a project in descending order, calculate the risks associated with each process and list the controls that may exist for each risk.

3) Factors affecting Risk:

Several factors expose projects to normal than higher risk.

a) History:

Latest projects create more risk since the process has not been developed with the course of time. If a project of related nature has been done many times before, then the possibility of success with the current project is also improved.

b) Management Stability:

Management stability means that the entire management team shares the same visualization and direction, thus leading successful achievement of goals. If the management is unstable then it can lead to unrealistic and impractical schedules for the project and inefficient use of resources.

c) Staff expertise and experience:

In the event that the members of a project team lack the direct working knowledge and experience of the area, there is a likelihood of time delays, expected cost upsets and poor quality.

d) Team Size:

In case of large teams, the chance of problem occurrence increases due to the team size. One of the reasons can be the difficulty of communication due to the large team size.

e) Resource Availability*:*

If the availability of resources is easy, the chance of responding to problems in real time also increases. For example, easy accessibility of money makes protecting human, material and equipment resources simple on as required basis. However, an abundance of resources does not provide guarantee against risks, all it does is to equip the project team with the tactics to respond to risks.

f) Time Compression:

At the condition of highly compressed time schedule, the risks are exaggerated in the project. When more time is available, more flexibility is present in the project and there is a chance to moderate and reduce the impact of occurring risks.

g) Complexity:

In case of a highly complex or sophisticated project, the opportunity of a mistake or a problem is also enhanced.

4) Types of risks:

Risks can be associated to technical, operational or business aspects of projects. A technical risk is the inability to build a product that complies with the customer's requirement. An operational risk takes places when the project team members are not capable to work cohesively with the customer. Risks can be either acceptable or unacceptable. Risks associated with the construction industry can be broadly categorized into:

a) Technical risks:

- Inadequate site investigation
- Incomplete design
- Appropriateness of specifications
- Uncertainty over the source and availability of materials

b) Logistical risks:

- Availability of sufficient transportation facilities
- Availability of resources-particularly construction equipments, spare parts, fuel and Labor

c) Management associated risks:

- Uncertain productivity of resources
- Industrial relations problems

d) Environmental risks:

- Weather and seasonal implications
- Natural disasters

e) Financial risks:

- Availability and fluctuation in foreign exchange
- Delays in Payment
- Inflation
- Local taxes
- Repatriation of funds

5) Common sources of risk in the construction projects:

The common sources of the risks in the construction industry are as follows:

- Changes in project scope and requirements
- Design errors and omissions
- Inadequately defined roles and responsibilities
- Insufficiently skilled staff
- Subcontractors
- Inadequate contractor experience
- Uncertainty about the fundamental relationships between project participants
- New technology
- Unfamiliarity with local conditions
- Force majeure

6) Major processes of project risk management:

Risk management involves four processes namely:

a) Risk Identification:

Determination of most likely risks affecting the project and documentation of characteristics of each risk

b) Risk quantification:

Assessment of risks and the possible interactions of risks with project activities to evaluate the possible outcomes of the project

c) Risk response development:

Definition of response steps for opportunities and threats associated with risks

d) Risk response control:

Response to the changes implemented to remove risks throughout the project duration

7) Response to risk:

There are five different categories of classic risk response strategies:

- Accepting
- Avoiding
- Monitoring
- Transferring
- Mitigating the risk.

a) Accepting the risk:

This category implies to understand the risk, its consequences and chance of occurrence, and not doing anything about it. The project team will react to the risk in case of occurrence. This strategy is commonly used in cases when the chance of a problem occurrence is minimal. This strategy makes sense for cases when consequences are cheaper than the cure.

b) Risk quantification:

Risk can be avoided by not doing part of the project which contains risk. Scope of the project is changed in this manner, which might change the business case as well, since a scaled down product could lead to lesser revenue or cost saving opportunities. More risk is involved with high return on an investment. Avoiding risks on projects can have same effect on low risk, low return projects.

c) Mitigate the risk:

Mitigation is process of response to the risk after it has affected the project. Mitigation covers all actions the project team can take to overcome risks from the project environment.

8) Advantages of risk management:

Following are advantages of risk management:

a) Achievement of objectives
b) Shareholders reliability
c) Reduction of capital cost
d) Less uncertainty
e) Creation of value
f) Reduce delay of project

9) Limitations of risk management:

If too much time is spent on the assessment and management of unlikely risks, then important resources can be diverted which otherwise could have been very profitable.

IV. RISK MANAGEMENT PROCESS

Numerous variations of risk management procedure have been projected. A process consisting of two main phases: risk assessment, which includes identification, analysis and prioritization, and risk control which includes risk management planning, risk resolution and risk monitoring planning, tracking and corrective action. An identified risk management approach as a multiphase `risk analysis' which covers identification evaluation, control and management of risks. "Acceptably" is as judged by the customer in the final analysis, but from a firm's perspective a failure is anything

accomplished in less than a professional manner and/or with less than-adequate result.

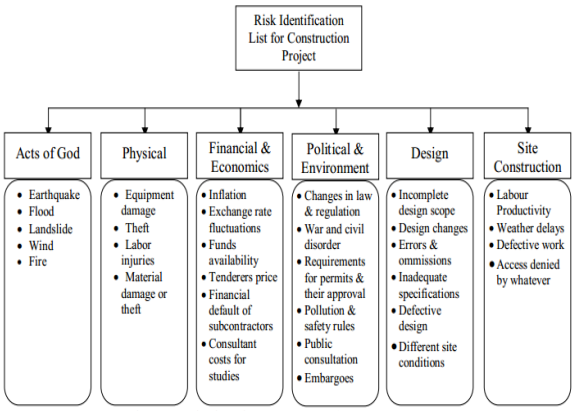

Figure-1 Risk Categorization List

It is possibilities that are being accommodated. It's management's work to do the preparation that will contain the possibilities. The client is the final judge, but internal goals be supposed to be a higher level than customer prospects. Risk management as a shared or centralized activity must achieve the following responsibilities:

- Identity concerns.
- Identify risks & risk owners.
- Estimate the risks as to possibility and consequences
- Assess the options for accommodating the risks.
- Prioritize the risk management efforts.
- Develop risk management plans.
- Authorize the implementation of the risk management plans.
- Track the risk management efforts and manage accordingly.

A) A Generic Risk Management Process Consisting Of Nine Phases:

1. Define the key aspects of the project;
2. Focus on a strategic approach to risk management;
3. Identify where risks may arise;
4. Structure the information about risk assumption and relationships;
5. Assign ownership of risks and responses;
6. Estimate the extent of uncertainty;
7. Calculate the comparative magnitude of the various risks;
8. Plan response;

According to the Project Management Body of Knowledge (PMI, 1996), risk management forms one of the so-called nine functions of project management (the other eight being integration, communications, human resources, time, cost, scope, quality and procurement management). The traditional view is that these functions should form the basis of planning and that each should be the focus of attention in each phase of the project. In the PMBOK, PMI (1996) presents four phases of the risk management process: identification, quantification, responses development and control.

B) Construction Risk Management Approach Conceptual Model

This model placed risk management in the circumstance of project decision making while considering the over-lapping circumstances of behavioral responses, organization structure, and technology. The objectives of project and construction risk management should be clearly established within the circumstance of project decision-making, and will be governed largely by the risk attitude of the project proponent. In discussing human judgments in decision making, proposes a sociological and organizational circumstance for risk analysis.

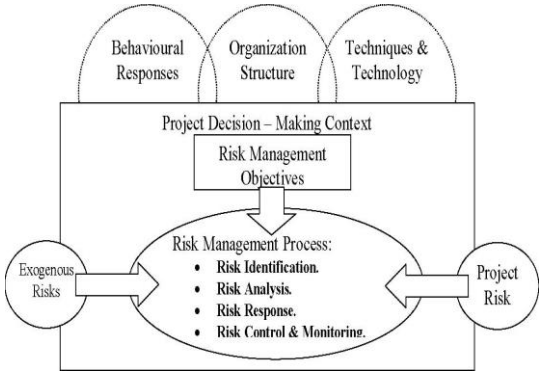

Figure-2 Conceptual Model of Construction Risk Management (Enshassi & Mayer, 2001)

C) Risk Identification

Risk Identification is the first stage in the risk management procedure and it involves detaining all the possible risks that could arise within the project. It is commonly acknowledged that of all the stages of risk management process, risk identification stage has the largest impact on the accuracy of any risk assessment. When attempting to identify risk, it is rather like trying to map the world. Maps of the world tend to be centered on the location of the map maker. Much of the world is not visible from where you stand. Some territory which is familiar and obvious to you may not be obvious to everyone. Similarly, looking at a large project from the top, with multiple layers of planning, complex vertical and horizontal interactions, and sequencing problems, resembles looking into the world map through a

fog. Management's ability to influence the outcome is limited to what they can see.

D) Basic Steps of quantitative risk analysis

As discussed previously, the main aim of the risk analysis is to determine how likely an unfavorable incident is to occur and the consequences if it does take place. When quantitative risk analysis is to be done, it is attempted to explain risk in numerical terms. To do this, it should go through a number of steps.

1. Define the consequence; define the required numerical estimate of risk.
2. Create a pathway; consider of all sequential proceedings that must occur for the adverse event to occur.
3. Build a model - Collect data; consider each step on the pathway and the corresponding variables for those steps.
4. Estimate the risk; once the model has been constructed and the data collected the risk can be expected. Included in this estimation will be an analysis of the effects of changing model variables to reflect potential risk management strategies.
5. Undertake a sensitivity and scenario analysis; Undertaking a risk analysis requires more information than for sensitivity analysis.

E) Sensitivity Analysis

Sensitivity analysis is a deterministic modeling technique which is used to test the impact of a change in the value of an independent variable on the dependent variable. Sensitivity analysis identifies the point at which a given variation in the expected value of a cost parameter changes a decision. Sensitivity analysis is performed by changing the values of independent risk variables to predict the economic criteria of the project. Sensitivity analysis is an interactive process which tells you what effects changes in a cost will have on the life cycle cost **(Flanagan & Norman, 1993)**. Sensitivity Analysis is the calculating procedure used for prediction of effect of changes of input data on output results of one model **(Jovanovich, 1999)**. It does not aim to quantify risk but rather to identify factors that are risk sensitive. Sensitivity analysis enables the analyst to test which components of the project have the greatest impact upon the results, thus narrowing down the main simplicity and ability to focus on particular estimates **(Flanagan & Norman, 1993)**.

F) Monte Carlo Simulation

Simulation is a chance-based technique where all uncertainties are assumed to follow the characteristics of random uncertainty. A random process is where the outcomes of any particular process are strictly a matter of chance **(Flanagan, 2003)**. The Monte Carlo process is simply a technique for generating random values and transforming them into values of interest, the methods of generating random or pseudo random numbers are more sophisticated now and the mathematics of other distributions is more complex. Different values of risk variables are combined in a Monte Carlo simulation.

V. RESEARCH METHODOLOGY

1- Data collection

Data collection was based on personal interview for filing questions. The personal interview, which is a face-to-face process, in which the respondents were asked questions with a brief explanation for the ideas and contents of questionnaire, was conducted. The number of respondents who agreed to cooperate was 49 out of 60 which represent 81% of the overall sample. On the contractors side the ratio was 80%, and on the owners' was 82%.

- **Personal Interviewing.**
- **Telephone Interviewing.**
- **Self-Administered Questionnaires/Surveys.**

1.1 Data Collection Ethics

The following ethics were strictly practiced in the Project:

1) **Informed consent: -**In this area I was gives the choice to Participant to participate or not to participate, and furthermore be informed in advance about the nature of the Project.
2) **Right to privacy: -**The nature and quality of participants' performance must be kept strictly confidential if they want.
3) **Honesty with professional colleagues: -** Findings must be reported in a complete and honest fashion, without misrepresenting what has been done or intentionally misleading others as to the nature of it. Data may not be fabricated to support a particular conclusion.

1.2 Questionnaire design

The questionnaire survey was conducted to determine the opinion of contractors and owners regarding the risk factors. A four pages questionnaire accompanied with a covering letter were delivered to 30 contracting companies

and 30 owner representatives (owners could be: ministries, municipalities, consultants, and so on) of five sections to accomplish the aim of this research, as follows:

1. The organization profile (contractor and owner)
2. Risk factors that have been identified by literature, experts and by the researcher.
3. Risk precautionary methods which could be used to keep away from risk to take place.
4. Risk mitigative methods that could be used to mitigate risk impact or likelihood.
5. Risk analysis techniques that could be used to analyze and estimate risk factors impact.

Table 1– An example for contribution of risks to a project (risk significance).

Types of risks	Contribution rank										Total weighted scores
	1	2	3	4	5	6	7	8	9	10	
Defective materials	2 (2)	0 (0)	3 (9)	1 (4)	8 (40)	5 (30)	4 (28)	4 (32)	2 (18)	2 (20)	183
Inaccurate quantities	2 (2)	0 (0)	0 (0)	1 (4)	1 (5)	1 (6)	9 (63)	4 (32)	7 (63)	6 (60)	235

❖ **Mitigative actions**

At the same time as some project delay risks can be reduced even if various preventive actions at early phases, the delay of improvement still occurs in many projects during the construction process. A current construction industry study has designated that over 80% of projects go beyond their scheduled time even with the employment of software techniques for project development. When delay takes place, contractors can adopt various mitigative actions to minimize the effects of the delay.

1.3 Data analysis

Analysis is an interactive process by which answers to be examined to see whether these results support the hypothesis underlying each question. Quantitative statistical analysis for questionnaire was done by using Statistical Package for Social Sciences (SPSS). The analysis of data is done to rank the severity of causes of contractor's failure. The opinion of contractors regarding the severity of each cause was checked by **analysis of variance** (ANOVA).

The following statistical analysis steps were done:

- Coding and defining each variable
- Summarizing the data on recording scheme
- Entering data to a work sheet
- Cleaning data
- Mean and rank of each cause
- Comparing of mean values for each main group and overall sub-factors
- ANOVA test was performed to test the dissimilarity of answers of contractors regarding to the variables.
- Partial correlation test was done to compare the mean values of different groups
- Multi-comparison test was also done when there is a significant difference.

VI. RESULTS AND DISCUSSION

6.1 Introduction

The aim of this study is to determine the risk factors in construction industry, allocation of these factors, methods used to deal with risks and the techniques adopted in analyzing these risks. The outcomes of this study are demonstrated in this chapter. Primarily, the severity of risk factors, distribution of each, methods of dealing with risks and performance of analysis. Then, a comparison will be held between contractors and owners' perspectives regarding the severity and allocation of each risk factor. Also, in this chapter the results and findings of this research are discussed in detail.

6.2 Risk factors – Contractors' perspective

As mentioned in chapter 5, the questionnaire included 43 risk factors, which have been categorized in nine main groups, these groups were: physical group, environmental group, design group, logistics group, economic (financial) group, legal group, production group, political group and the management group. The factors of each group will be demonstrated in the terms of severity and allocation according to the participants answers.

6.2.1 Physical group (Group 1)

6.2.1.1 Severity

Results confirmed that the supply of the defected materials is the most significant risk in the physical group, occurrence of accidents was the second from the significance and the third was the deviation in labor and equipment productivity. These results indicate the concerns of contractors about suitability of materials and safety measures; this result is supported by the results of **Ahmed, et al. (1999)** and the conclusions of National Audit Office (2001) which considered the risks of defect materials and safety measures as very important risks.

6.2.1.2 Allocation

The criterion for a risk to appropriated to a specific category (like owner, contractor, shared, insurance), was that it should obtain at least (60%) response rate to achieve the mainstream of the rates. Individuals that failed to get such response rate in support of any category were scheduled as unresolved. As revealed in Figure (6.1), about 39% of contractors tried to shift the consequences of accidents to the other parties such as insurance, about 42% of contractors appeared to be ready to bear these consequences and near about 19% of them appeared to share these consequences with owners. That means that contractors are undecided about the allocation of safety risks and unlike contractor who accepted to bear the safety risks. Actually the contractors are better capable to control such types of risks by managing the application of safety measures in the interior the construction sites. Furthermore, the existence of the insurance premiums for the accidents and the damages can moderate some of this risk effect. Contractors are supposed to knowingly pay more effort to mitigate the accidents costs and other consequences by applying effective training and increasing awareness of safety precautions.

Table 6.1 Physical group contribution of risks to a project

Types of risks	Contribution rank										Total weighted scores
	1	2	3	4	5	6	7	8	9	10	
Occurrence of accidents because of poor safety procedures	0 0	0 0	2 6	2 8	2 10	2 12	4 28	5 40	4 36	4 40	180
Supplies of defective materials	0 0	0 0	0 0	2 8	1 5	3 18	5 35	5 40	4 36	5 50	192
Varied labor and equipment productivity	2 2	0 0	4 12	3 12	2 10	2 12	3 21	2 16	3 27	4 40	152

Table 6.1.1 Physical group risks ranking

No.	Physical Group Risks	Weight	Severity (1-10)
2	Supplies of defective materials	192	7.7
1	Occurrence of accidents because of poor safety procedures	180	7.2
3	Varied labor and equipment productivity	152	6.1

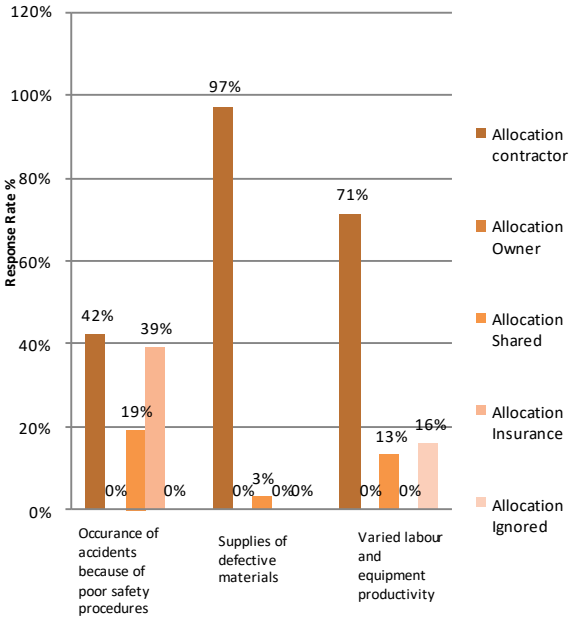

Figure 6.1. Physical group risks allocation, contractors' perspective

VII. CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This study was carried out to identify the construction industry risk factors, their importance and their allocation. Moreover, risk management actions, risk analysis techniques and their effectiveness and usage were settled on. The above topics were examined from contractors and owners' perspectives. These objectives were brought out, some tendencies were concluded and some actions that may improve risk management practices were recommended. Risk management technique rarely used by the participants in construction projects. The participants used to handle the risks with an informal approach. This technique is not employed because of less knowledge and awareness among the construction industry. The risk management technique should be applied into any construction project at the initial stage of the project to get maximum benefit of the technique. Hence, there is thriving need to have a well-documented procedure which should be a one stop solution to all hazards that are likely to occur during project life cycle. There should be more wholesome approach towards risk management instead of the present sporadic approach towards the risks.

7.2 Conclusions

The construction industry has characteristics that sharply distinguish it from other sectors of the economy. It is

fragmented, very sensitive to economic cycles, and highly competitive because of the large number of firms and relative ease of entry. It is basically due to these unique characteristics considered a risky business. In this study, identifying the risk factors faced by construction industry is based on collecting information about construction risks, their consequences and corrective actions that may be done to prevent or mitigate the risk effects. Risk analysis techniques were investigated too. However, determination of severity and allocation of these risk factors was the main result of this research. The focal point of this research is to explore the key risk factors and identify these factors that could be faced in construction industry. Analysis of these risk factors was carried out to measure their effects on building projects and to assign each risk factor on the party who is in the best position to handle such situations. The risk factors that were identified are shown in Table (5.1). These factors were investigated to measure the severity of each. The most ten sever risk factors are appeared in Table (7.1).

Table 7.1. Most ten sever risk factors and allocation according to contractors

Rank	Risk Description	Allocation
1	Financial failure of the contractor	Contractor
2	Working at hot (dangerous) areas (close to IDF positions)	Shared
3	Closure	Shared
4	Defective design (incorrect)	Owner
5	Delayed payments on contract	Owner
6	Segmentation	Undecided
7	Unstable security circumstances (Invasions)	Shared
8	Poor communication between involved parties	Shared
9	Unmanaged cash flow	Contractor
10	Awarding the design to unqualified designers	Owner

On the other hand, owners had a different opinion about the most ten sever risks, they ranked:

Table 7.2. Most ten sever risk factors and allocation according to owners

Rank	Risk Description	Allocation
1	Awarding the design to unqualified designers	Owner
2	Defective design (incorrect)	Owner
3	Occurrence of accidents because of poor safety procedures	Contractor
4	Difficulty to access the site (very far, settlements)	Undecided
5	Inaccurate quantities	Undecided
6	Lack of consistency between bill of quantities, drawings and Specifications	Undecided
7	Working at hot (dangerous) areas (close to IDF positions)	Shared
8	Financial failure of the contractor	Contractor
9	Closure	Shared
10	High competition in bids	Undecided

The results showed the difference between contractors and owners evaluation of risks; the results show that contractors considered (57%) of the risk factors as highly important risks and (43%) of them as medium risks. However, owners considered only (11%) of the risk factors as highly important risks and (89%) of them as medium risks. That reflects the high concern of contractors about such issues. More details are in section (6.3.1 and 6.5.1). Contractors were more specific in allocating risks and were more likely to share these risks with owners who were undecided about 45% of risks, but contractors were undecided about 37% of risks. Contractors allocated 20% of risks on themselves, 18% on owners and 25% to be shared. Owners allocated on themselves 14% of risks, 23% on contractors and allotted 18% of risks as shared. (See sections 6.3.2 and 6.5.2). It was noted that no risk factor has been assigned out of the previous three categories (contractor, owner and shared) despite the existence of other two areas; insurance and ignored. Comparison between the two viewpoints is elaborated in Table (6.13). Contractors and owners still depend on traditional approaches to manage risk factors and their consequences; the use of direct judgment to control risk factors was the most applied method used to control risk events (sections 6.7 and 6.8). These results assure the need to develop the used methods for managing risk factors. Use of quantitative methods, computer systems or sensitivity analyses were not practiced by respondents, they also depend on direct judgment and comparing analysis to analyze risk consequences (section 6.9).

7.3 Recommendations

7.3.1 Recommendations to contractors

- Contracting companies should compute and consider risks by adding a risk premium to quotation and time estimation. This trend has to be supported by organizations like Contractors Union, PECDAR, UNRWA, UNDP and other organizations concerned about the construction industry.
- Contractors should struggle to prevent financial failure by practicing a stern cash flow management and minimizing the dependence on bank loans.
- Contractors should learn how to share and shift different risks by hiring specialized staff or specialized sub-contractors.
- Contracting firms should utilize computerized approaches used for risk analysis and evaluation such as @Risk package which integrates with widely used programs like Microsoft Project and Microsoft Excel. Otherwise, apply manual approach.
- Moreover, contractors should work on training their personnel to properly apply management principles. It is the duty of institutes to provide such training.

7.3.2 Recommendations to owners

- Tenders should be awarded to accurate expected cost and not necessarily to the lowest bidder. This could take the edge of high competition in bids and reduce risk's consequences by providing more profit margin for contractors.
- Exchange rate fluctuation should be considered as a risk factor by owners and donors and they should offer a compensation mechanism if there was any damage due to this risk.
- The contract clauses should be modified and improved to meet the impact of closure and not to allocate the whole impacts on the contracting companies. These contracts are supposed to make companies make profits.
- Owners should conduct continuous training programs with cooperation with PCU to advance managerial and financial practices to explain the internal and external risk factors affecting the construction industry and to initiate the proper ways to deal with such factors.

7.3.3 Shared recommendations

- Possible risks should be allocated contractually and clearly on each party. That could be done by defining the potential risk factors and allocate them on the party which is in the best place to manage these risks.
- Both contractors and owners have to be more aware about safety measures.
- A satisfactory level of communications between parties should be maintained to convey needed information emphasizing documentation.
- Specialized construction arbitrators are needed to help in settling conflicts and disputes in a way the amalgamate legal and construction needs.
- Documentation works should be applied widely in the industry. In addition, contractors and owners are requested to keep computerized historical data of finished projects. This may help in rights reservation and to be an information source for future comparison.
- There is an essential need for more standardization and effective forms of contract, which address issues of clarity, fairness, roles and responsibilities, allocation of risks, dispute resolution and payment – this could be done by adopting a standard form of contracts
- There should be an addendum or addenda for every standard contract defining the risk factors associated with construction industry and the allocation of every factor.

7.3.4 Recommendations based on the findings of case study

- Contractors should provide the professional staff to manage the project properly, which will considerably reduce the cost and time of execution.
- Contracting companies should maintain a satisfactory level of communication between the home office and field offices and apply appropriate management practices.

7.3.5 Proposed future studies

- It is necessary to repeat this research every 2 years by an authorized institute to survey the new risk factors and their allocation, and publish the results for owners and contractors.

REFERENCES

[1] Ahmed, 2001 Risk Management Assessment Systems: An Application To Islamic Banks.
[2] Akintoye, A. S. & MacLeod, M. J. (1997). Risk analysis and management in construction. International Journal of Project Management, 15(1), 31.
[3] Akintoye, A.S. and MacLeod, M.J.; "Risk analysis and management in construction"; International Journal of Project Management (1997) application of new management ideas in construction.
[4] Baccarini, D., Archer, R. (2001), the risk ranking of projects: a methodology, International Journal of Project Management, Vol 19, pp 139-145.

[5] Baker S., Ponniah D., Smith S. (1998), Techniques for the analysis of risk in major projects, Journal of the Operational Research Society, Vol 49, pp 567-572.
[6] Berny, J. and Townsend, P.R.F. (1993), Macrosimulation of Project Risks - a Practical Way Forward, International Journal of Project Management, Vol. 11, No. 4, pp. 201 - 208.
[7] Chapman, C. & Ward, S. (2004). Why risk efficiency is a key aspect of best practice projects. International Journal of Project Management, 22(8), 619.
[8] Construction and Architectural Management, 8(5/6), 335-345. IEC62198:2001. (2001). International Standard IEC 62198:2001: International Electro technical Commission.
[9] Cooper, D.F., MacDonald, D.H. and Chapman, C.B. (1985), Risk Analysis of a Construction Cost Estimate, International Journal of Project Management, Vol. 3, No. 3, pp. 141-149.
[10] Cumming, Christine and Beverly J. Hirtle (2001), "The Challenges of Risk Management in Diversified Financial Companies", Economic Policy Review, Federal Reserve Bank of New York, 7, 1-17.
[11] Dariusz Skorupka,; "Risk management in building projects"; AACE International Transactions (2003).
[12] Dey, P.K. (1999), Process re-engineering for effective implementation of projects, Internationa Journal of Project Management, Vol. 17, No. 3, pp. 147-159.
[13] Dey, P.K., Tabucanon, M.T., Ogunlana S.O. (1994), Planning for project control through risk analysis: a petroleum pipeline-laying project, International Journal of Project Management, 12, pp. 23-33.
[14] Dilesh Pardhi Anand Kumar Patil,; "Risk Management In BOT Projects", (2008)
[15] F. Y. Y. Ling and L. Hoi, "Risks faced by Singapore firms when taking construction projects in India," 2006.
[16] Flanagan R, Norman G, Chapman R, 1993 Risk management and construction. 2nd ed. Institution of Civil Engineers and the Actuarial Profession Risk analysis.
[17] Kartam, N.A. and Kartam, S.A. (2001) Risk and Its Management in the Kuwaiti Construction Industry: A Contractors' Perspective. International Journal of Project Management (Compendex), 19, 325-335.
[18] Kinnaresh Patel M.E. (C.E.M.), A study on risk assessment and its management in India,; AJCE (2013).
[19] L. Bing and R. L.K Tiong, "Risk management model for international construction joint ventures,"1999.
[20] Lyons T. and Skitmore M., 2004. Project risk management in the Queensland engineering construction industry: a survey. International Journal of Project Management. Vol. 22, pp. 51- 61.
[21] M. Hastak and A. Shaked, "ICRAM-1 Model for international construction risk management,"2000.
[22] M. J. Kolhat.kar, Er. Amit Bijon Dutta,; "Study of Risk in Construction Projects", ;GRA (2013), management for projects (RAMP). 2nd ed. Institution of Civil Engineers.
[23] Mehmood Alam, Dr. Nadeem Ehsan, Ebtisam Mirza, Azam Ishaque,;"Risk Management in construction industry",;(2010). Oxford: Blackwell Pub; 2006.
[24] Prof. Shakil S. Malek, Nazneen I. Pathan, Haaris Mal,; "Risk Management in Construction Industry",; IJAR (2013)
[25] Project Management Institute. Construction extension to the PMBOK® Guide. 3rd ed. Newtown Square: Project Management Institute; 2007.
[26] Project Management Institute. Guide to the project management body of knowledge
[27] projects: time for a fundamental shift. International Journal of Project Management, 19(2), 89-101.
[28] S. Q. Wang and M. F. Dulami, "Risk management frame work for construction projects in developing countries,"2004.