International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 14, Number 8 (2021), pp. 848-852

Forecasting the Cost Contingency in Construction Projects Using Risk Management Technique

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Abstract

Every human endeavor or action carries risks. In our daily life, everyone goes through a variety of situations which involve many unknown, unexpected, often unwanted and often unpredictable factors. These factors can be grouped under the category of risks and the contracting industry like any industry that goes through a variety of risks that naturally lead to an increase in the cost over the expected estimated cost.

Also, no construction project is free from risks and thus the situation becomes worse for contractors due to the competitive environment in general. These risks can directly affect the costs, quality and duration of the project. Contractors are subject to a variety of risk factors that are a result of the participation of various parties in the various stages of project implementation, and the implementation of the project according to the expected cost.

The purpose of estimating the contingent costs in construction projects using the risk management technique is to help companies working in the construction field to correctly estimate the project cost before submitting their bid in a sound scientific manner, in addition to avoiding any sudden increase in the project cost during its implementation which could lead to significant losses.

This research discussed the prediction of the ratio of increase in the cost of construction projects using risk management, and to do this risks and contingencies were defined, and then the risks facing contracting companies shall be identified, which could lead to an increase in the cost of projects, and then a survey was conducted for contractors to measure the extent of these risks in addition to the rate of increase in the event of risks occurrence.

The results obtained were in line with the pre-set objectives which are as follows:

1.1. Identifying the sources of risks that may face contractors:

To achieve this objective, the risks facing contracting companies have been studied, whether through published research or through previous studies, or through field visits to survey contractors and consultants about the most prominent problems that may face them. These problems were summarized in the form of 71 risks or problems that they may face during the project life cycle. and explain contingency ، statement Contingencies in construction industry and explain Contingency Estimation Methods

1.1.1 **Meaning of Risk**

Since there are many different definitions for ‘risk’ this section aims to give a theoretical overview as well as pinpointing the definition used in this thesis. Risk has been variously defined as:

> (Fraser 1978)(1) Define the probability of risk as " Risk could mean that some unforeseen event will occur to upset existing plans, or that there is great uncertainty as to whether some damaging event will occur or not, or that some damaging even is very likely to occur, or that if some damaging event occurs, some amount of money will be involved.
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> (Lifson and Shaifer 1982)(1) Defined the risk as "the uncertainty associated with estimates of outcomes. He pointed out that Risk means that there is a chance that results could be better than expected as well as worse than expected"
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> (Jaafari and Schub 1990)(2) Defined risk as the presence of potential or actual constraints that could stand in the way of project performance, causing partial or complete failure either during construction and commissioning or at the time of utilization.

1.1.2 Risk Types And Classifications

Too many trials were made to classify the different risks in construction. Risks were classified according to either their nature or their consequences (controllable, quantifiable). All

classifications were mainly done as a prerequisite to the management of the risks.

1.1.2.1 Classification by Nature

(Johnson and Rood 1977)[1] Classified risks into the following categories: (1) business risks, (2) project risks, and (3) operation risks.

(Erikson 1979)[3] classified risk as contractual risks and construction risks. Contractual risks arise primarily from the interaction among the different parties to the construction process. Contractual risk is introduced through clarity of contract, absence of communication between the parties involved, and problems of timeliness in contract administration. Construction risks, on the other hand, arise from factors such as weather, differing site conditions, acts of God, resource availability, etc. Construction risk is inherent in the work itself.

(Abdou 1996)[4] classified construction risks into three groups, i.e. construction finance, construction time and construction design, and addressed these risks in detail in light of the different contractual relationships existing among the functional entities involved in the design, development and construction of a project.

(Conroy and Soltan 1998)[5] refer to four categories of risk, namely human failings, organizational failings, design group failings and design process failings.

(Tah and Carr 2000)[6]categorized risks into two groups in accordance with the nature of the risks, i.e. external and internal risks. the authors grouped risks into six subsets: local, global, economic, physical, political and technological change.

(Shen 2001)[4]categorized them into six groups in accordance with the nature of the risks, i.e. financial, legal, management, market, policy and political, as well as technical risks.

1.1.2.2 Classification by Consequences

This classification describes common features that all the different risks may follow. This was done as a prerequisite for managing risks.

Levitt (1980)[7] categorized risks into two types controllable and uncontrollable. Controllable risks reflect variations in human performance such as number of design omissions, low worker productivity and material wastage. Uncontrollable risks are random variables such as material price escalation, weather and unpredictable changes in underground conditions or properties.

Wideman (1986)[8] has compiled a risk identification breakdown structure as a framework of the major sources of risk which is subdivided into five classifications of risk: external unpredictable, external predictable but uncertain, internal (non-technical), technical and legal.

Franke (1987)[9] classified risks into quantitative risks and qualitative risks. He defined the quantitative risks, as those require numerical data for their identification, where the costs of which can be forecasted. But the qualitative risks are best expressed in linguistic terms e.g. high, medium, or low, where the cost effects of which cannot be assessed directly. He made the classification in order to analyze and assess the qualitative risks which includes the following:

- Risks resulting from dependencies (customer, suppliers...).
- External influences (authorities, politics...etc.).
- Uncertainties as to payment, liability (delay, penalty….).

1.1.3 Sources Of Risk For Construction Contractors

There are many risk factors affecting the construction contractors. Those risk factors could result from different sources and parties. Through the literature review, many interviews and discussion with some professionals in the field, and the writer's experience, many risk factors have been identified. There are seventy-one potential factors identified. Those factors could be combined into eleven major groups. These groups are classified according to sources of these factors. These sources are the following:

1.1.3.1 Construction and Job Site Risk Factors 15 factor (

Low productivity of labor , Labor disputes and unrest , The lack of skilled labor and labor's weak experience. , Accidents at the site and labor's injuries and illnesses , The lack of resources (labor, equipment, Material) , Delay in suppling material , Increased waste of materials. , Equipment malfunction during implementation. , Low productivity of equipment , Obtaining non-conforming quality (poor quality). , Defects in the implementation of works. , Delay in project duration., Poor safety regulations and instructions during on-site implementation.

Some structures cracked during implementation. ,Suspension of work

1.1.3.2 Design Risk Factors: -

The lack of engineering drawings and information., Errors, ambiguities, and inconsistency with project specifications. , Modification of designs by the owner or his representative during construction. , Errors in designs. , Difficulty and , complexity in designs and hence difficulty in construction and implementation.

Delay in the delivery of detailed drawings.

1.1.3.3 Financial and Economic Risk Factors (6 factor)

Loss due to price inflation (price increases for materials, workers, equipment, ... etc.). , Depreciation of the local currency and fluctuation of exchange rates

Cost overrun from on planned cost . , Delay in paying the sums owed to the contractor by the owner. , Liquidity problems of the contractor and the difficulty of financing the project. , Pay a penalty for the delay

1.1.3.4 Management Risk Factors: - (12 factors)

Weak communication and coordination between project parties during implementation during implementation. , The availability of some bad features in the project management team, such as the lack of experience, inefficiency and incompatibility with the work team. , Inefficiency in project planning and scheduling by the contractor's administration . , The internal organization (the structural composition of the administration and the project system) is inadequate. , Administrative weakness in the calculation of quantities and benchmarking. ,Delays in preparations to start work by contractor and delay or mistake in field survey work of the site.. , Error in choosing the type and location of the project. , Change in project personnel during its implementation. , Bad accelerate of project handover using additional resources., The contractor's fault in the technical study of project during the tender stage. , Shortage of administrative personnel of the contractor , Thefts at the project site.

1.1.3.5 Owner Risk Factors: -

Delay in delivering the site to the contractor by the owner. ,Delay in settlement of contractor's Claims by the owner., Suspension of project works by the owner. , Delayed decision making by the owner. , Intervention of the owner in the implementation process's phases. , Failure of the owner to cooperate with contractor. , Increasing red tape procedures by the owner. , Changes the scope of work of project (quantities of items, new items, new areas, ... etc.) by the owner. Determining short implementation period by the owner in the contract of project.

1.1.3.6 Supervision Risk Factors: -

Poor qualifications of the supervising administrative staff. , Consultant delays in approving the contractor's explanations (such as material samples, plans, schedules, requests for payment of extracts ... etc.). , Consultant delays in performing the necessary checks and tests. , Conflict between the contractor and the consultant during the construction phase.

1.1.3.7 Subcontractor Risk Factors: -

The lack of the credibility of subcontractors Shortage of subcontractors. , Problems between the subcontractor and the main contractor. , Liquidity problems of subcontractors

1.1.3.8 Site Conditions Risk Factors: -

The change and difference in the condition of site (entrance of site, neighboring infrastructure, buildings around the site, etc.). , The lack of utilities (electricity, water, gas, etc.) , The effect of underground conditions (different soil composition, presence of public utilities, high water table, etc.). , Difficulty of accessing the site. , The influence of social conditions and traditions.

1.1.3.9 Adverse Weather and Natural Risk Factors: -

The effect of extreme weather conditions in the project area (the effect of extreme hot or cold weather, increased rain, wind and sandstorms, etc.) , Incidence Floods and torrents , Incidence Earthquakes , incidence Volcanoes ., incidence A fire occurred at the site

1.1.3.10 Legal Risk Factors: -

Delay in obtaining legal rights., Legal disputes between the parties involved in the project

1.1.3.11 Government Regulation and Policies Risk Factors: -

Difficulty and restrictions in obtaining work permits from the concerned authorities ., Changes in laws and regulations (taxes, employment, trade, ... etc.) ., Loss as a result of war, civil turmoil, revolution, popular turmoil, etc.).

1.2 Contingencies in construction industry

1.2.1 Meaning Of Risk

A contingency is a predetermined amount or percentage of the contract held for unpredictable changes in the project. This contingency is a risk-managing tool that financially prepares owners for addressing risk within the project. Contracts are given for contingencies to pay for unknown conditions such as the price escalation of a product, design changes in scope or due to errors and omissions,

Acoording to (Jeremy Hobbs, 2010)[10] (AACE) defines contingency as, "An amount added to the estimate to (1) achieve a specific confidence level, or (2) allow for changes that experience shows will likely be required.

1.2.2Construction contingency and types of construction contingency

Acoording to(Baccarini D. , 2006)[10]:

1. The amount of money available as a cost contingency at any time in the project is a function of the cost risks associated with the project at that time

2. From the perspective of decision makers, the inclusion of contingencies within the overall project budget means that the budget reflects the total financial commitment they are prepared to make to cover the known and unknown elements of the project. Contingencies therefore should reflect actual risks to the project budget as well as decision-makers own comfort level with risk.

3. The contingency affects the behavior of stakeholders to the project: set too high and the project may look unappealing to decision-makers or sponsors and therefore a valuable opportunity may be passed up. Set too low and decision-makers may choose to undertake a project without full understanding of the risks, which exposes the larger organization should costs exceed the estimate. Stakeholders to projects can also tend to view the contingency as a 'slush fund' from which they can fund discretionary changes to the project, which defeats the purpose of the fund.

1.2.3 Contingency Estimation Methods

As mentioned previously, contingency is a cost that included in the project cost due to risks and uncertainties associated with a project. In other words, contingency is meant to offset the cost impact of uncertainties and risks that influence a project. This shows the importance of identification the different methods of contingency estimation.

The Association for the Advancement of Cost Engineering (AACE, 2008) categorizes the methods to estimate risk cost and establish contingency in four major groups:

1.2.3.1 Expert judgment : An expert or a group of experts with strong experience in risk management and risk analysis define(s) the percentage of contingency for the project under consideration.

1.2.3.2 Predetermined guidelines : A set of predetermined contingency values is provided for different key phases of certain project types.

1.2.3.3 Simulation analysis : Including range estimating and expected value: This method usually integrates expert judgment with an analytical model. Then a simulation process such as Monte Carlo simulation is employed to obtain probabilistic output;

1.2.3.4 Parametric modeling : This method usually quantifies the amount of cost growth using risk drivers by the means of multi variable regression or artificial neural network.

According to(A. ARİF ERGİN July 2005)[11] . Schneck et al. (2009) classified the methods of contingency calculation into

1.3 Determining the probability of occurrence of each risk factor and Rate of increase in the cost of project:

To achieve this objective, I conducted a field study aimed in its first part to find out the possibility of occurrence of each of the 71 factors and in second part to find out the Rate of increase in the cost of project for each factor , as the survey was distributed to 208 contracting companies in the Arab Republic of Egypt, Kingdom of Saudi Arabia, United Arab Emirates, Republic of Cyprus and State of Kuwait, of whom only 133 companies responded, with a response rate of approximately 67.3% (7 surveys were canceled because the answers were not logical, especially since questions were asked that had nothing to do with reality to measure the credibility of whoever filled out the survey) and The results are as follows:

The results of the survey are divided into two main parts, the first part relates to contractors' responses to general questions, while the second concerns the contractors' responses to the 71 risks, where the response is divided into two parts. The first part relates to the probability of occurrence while the second part relates to the rate of the expected increase.

With regard to the first part of the survey, the results were as follows:

1. With regard to the classification of contracting companies, we found that 66 contractors were the companies that they work for fall within the framework of contracting companies classified first class, with a rate of 49.6% of the respondents, while the contracting companies classified third class came second in terms of the number of respondents of 38 companies, representing 28.6%, while the contracting companies classified in the second class came third in terms of respondents of 21 companies, representing 15.8%, while the contracting companies of the fourth and sixth classes came the last two classes equally in the number of companies (4 companies for each class), representing 3% per each.

2. Regarding the years of experience in the field of implementing construction projects, the answers varied, as 41.4% of the respondents had experience of more than 25 years, while 18% of companies stated that their experience was between 15 to less than 25 years in implementing construction projects, while some participants stated that their experience in the field of construction ranges between 5 to 15 years, representing for 12.8% of the respondents, while the equivalent of 10.5% of the respondents stated that their experience in implementing construction projects did not exceed five years.

3. With regard to the type of projects on which the responses of the companies participating in the survey relied, there were 58 contractors, representing 43.6%, stated that the projects on which their responses relied were government projects and private projects, while 41 contractors, representing 30.8% stated that the projects on which their responses relied on were private projects, while 34 contractors, representing 25.6% of the contractors, stated that the projects that their responses relied on were government projects.

4. With regard to costs, 100% of contractors stated that they exceeded the previously planned cost due to the risks they face, and that the percentages differ according to different problems, where 15.8% stated that they were subjected to permanent cost overrun, while 35.3% of contractors stated that they usually exceed the project cost than planned While 48.9% said that they sometimes suffer from an increase in costs over the planned, while no respondent mentioned that he did not face an increase in the cost of the project, and this reinforces the importance of this research.

As for the second part of the survey, construction contractors were stated in the first section of the second part that the most important risks that they face during the project life cycle are order from most occurring to least occurring as follows:

1. Modification of designs by the owner or his representative during construction, as the risk probability ratio is of 64.20%.

2. Delay in project duration, as the risk probability ratio is of 63.0%.

3. Changing the scope of work of project (quantities of items, new items, new areas, etc.) by the owner, as the risk probability ratio is of 62.8%.

4. Delay in paying the sums owed to the contractor by the owner, as the risk probability ratio is of 61.6%.

5. Intervention of the owner in the implementation process's phases, as the risk probability ratio is of 61 %.

6. The lack of the credibility of subcontractors, as the risk probability ratio is of 60.61 %.

7. Delayed decision making by the owner, as the risk probability ratio is of 60.6 %.

8. The availability of some bad features in the project management team, such as the lack of experience, inefficiency and incompatibility with the work team, as the risk probability ratio is of 60.6%.

9. Liquidity problems of the contractor and the difficulty of financing the project, as the risk probability ratio is of 60.6%.

10. A liquidity problem of the subcontractors, as the risk probability ratio is of 60.40%.

While it became clear to us through the second section of the second part of the survey that the rates of increase in the cost of projects occur in varying proportions depending on the risk itself, as some risks lead to an increase in the cost of project at high rates, while other risks, if they do occur, lead to a slight increase in the cost of project.

By reading the results of the statistical analysis, it becomes clear that the risks that lead to a greater increase in the cost of the project are in order from highest to lowest as follows:

1-Loss as a result of war, civil turmoil, revolution, popular turmoil, etc.), by a rate of increase of up to 30.47%.

2- Inefficiency in project planning and scheduling by the contractor's administration. 25.92%.

3- Determining short implementation period by the owner in the contract of project. 25.59%.

4- Delay in project duration. 29.53%

5- Defects in the implementation of works. 26.10%

6- Suspension of work. 23.85

7- Obtaining non-conforming quality (poor quality). 23.75%

8- Changing the scope of work of project (quantities of items, new items, new areas, ... etc.) by the owner. 23.56%

9- Modification of designs by the owner or his representative during construction. 22.24

10- Delay in suppling material. 22.03

11- Loss due to price inflation (price increases for materials, workers, equipment, ... etc.). 21.16

12- Project cost exceeded the planned cost. 21.12

13- The lack of utilities (electricity, water, gas, etc.). 20.82

14- Intervention of the owner in the implementation process's phases. 20.57

15- Errors, ambiguities, and inconsistency with project specifications. 20.11

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