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# Forecasting the Cost Contingency in Construction Projects Using Risk Management Technique

Mohammed Alhazmi<sup>1</sup>, Mostafa Qotb<sup>2</sup>, Ibrahim Abdalrashid<sup>3</sup>

PhD Student, Dept. of Structural Engineering, Faculty of Engineering, Al-azhar University, Cairo, Egypt.<sup>1</sup>

Professor, Dept. of Structural Engineering, Faculty of Engineering, Al-azhar University, Cairo, Egypt.<sup>2</sup>

Professor, Dept. of Structural Engineering, Faculty of Engineering, Ain shams University, Cairo, Egypt.<sup>3</sup>

**ABSTRACT:** The cost management of construction projects is a major success criterion for project owners, and the contingent cost shall be included in the budget estimation so that the budget represents the total financial commitment of the project sponsor. Therefore, estimating the contingent costs and their ultimate sufficiency is of critical importance for projects.

**KEYWORDS:** Cost, Risk Management, Contingency, Construction Projects.

## I. INTRODUCTION

The purpose of this research is to develop a model or program to determine the contingencies during the bidding stage for projects. Although identifying contingencies is an important stage of the bidding for projects, but the methods used by contractors in quantifying project-related contingencies are very limited. Moreover, it is almost impossible to make an estimate with an adequate amount of contingency as it requires a lot of time and data. Therefore, the contractors are required to develop a model that calculates the contingency by analyzing the possible inputs in an effective manner.

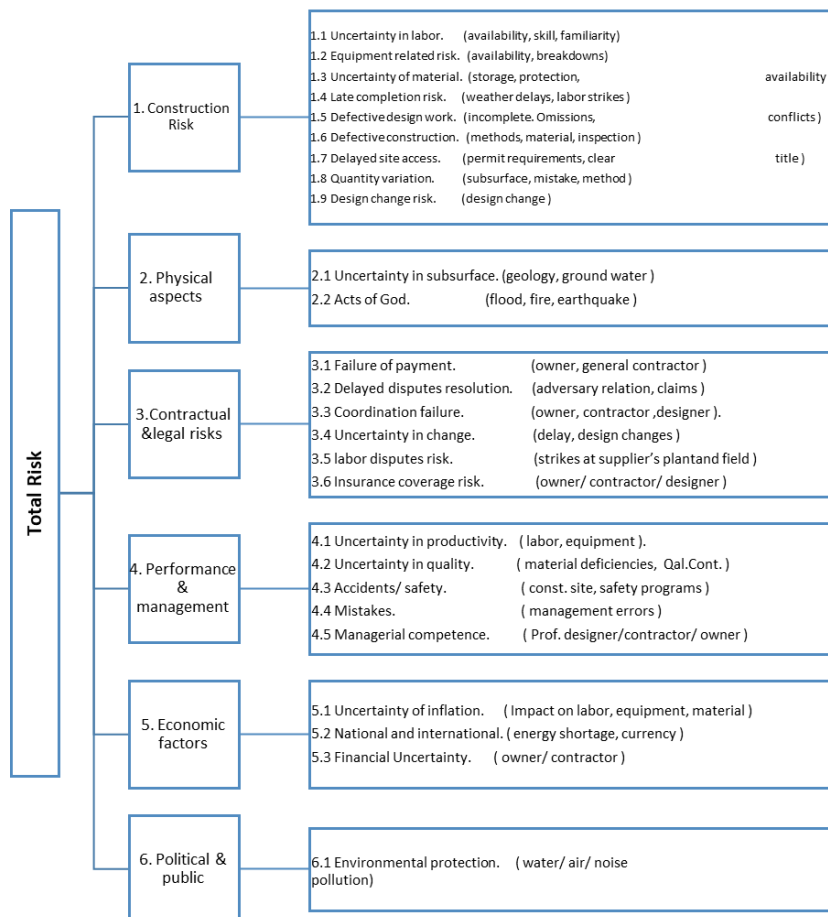
## II. MEANING OF RISK

(Kartam and Kartam, 2001)(1) Define the risk as "the probability of occurrence of some uncertain, unpredictable and even undesirable event(s) that would change the prospects for the profitability on a given investment", and in relation to construction; risk is described as "an exposure to economic loss or gain arising from involvement in the construction process

### 1.2.1 RISK TYPES AND CLASSIFICATIONS

#### 1.2.1.1 Classification by Nature

An appreciated work for risk identification was done by (Kangari& Boyer 1981)(4). Risk of all major parties involved in a construction project (contractors, designer, and owners) were collected and stored in data base files as a part of a knowledgebased system for risk management. Risks were collected from different sources as experts from the American Society of Civil Engineering; different research works for risk analysis, contractors (having 10 years of construction experience). Risks were classified under six primary sources of risk and uncertainty factors as shown in Fig (a)Structure of Risk Factors (Kangari& Boyer 1981)



(a) Structure of Risk Factors

## 1.2 Classification by Consequences

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

Farid (1989)(2) mentioned that the total risk of a project is comprised of two parts systematic risk and unsystematic risk. Systematic risk includes unanticipated increases in inflation or interest rates, labor shortages, and economic downturn or recession. Unsystematic risks include unexpected job conditions, strikes, and particularly financial difficulties.

## II. METHODOLOGY

Therefore, the main objective of this paper is to suggest a method for allocating appropriate contingencies using the risk analysis methodology.

This research aims to predict the rate of increase in the cost of construction projects using risk management techniques. To achieve the objectives of this research, the following steps have been defined:

1. Identifying the sources of risks that may face contractors
2. Determining the probability of occurrence of each risk
3. Conducting a survey of construction contractors to determine the likelihood of risks and estimate their financial impact on the project as a percentage.
4. Analyzing the results and making appropriate suggestions.
5. Developing a program whose inputs depend on risk factors, and its outputs shall be the rate of increase in the cost of project.

### III. EXPERIMENTAL RESULTS

#### 1.3 What's Contingency?

The contingency is a pre-defined sum of money or the kept percentage of the contract for the un-expected changes in the projects. In this contingency case, it is the tool for managing the risks to prepare the money owners to face the risks inside the project. The contracts are awarded to the cases of the contingency to pay for the costs of un-known conditions such as a rise in the price of the product or the changes in the design in the scope or due to the mistakes or changes in the necessary conditions of the construction which are achieved in the site during the construction process. The owners must attempt hard to provide a healthy contingency case for the project to overcome the cases related to the risks. If it was managed correctly, the contingency can provide a safeguard for the design and the contractor and the entrepreneur to complete the project with a budget (Molosewa Stevan, 2014).

##### 1.3.1. The Methods used for Calculating the contingency :

Figure (b) shows all the familiar methods where these methods are explained in details in the following sections

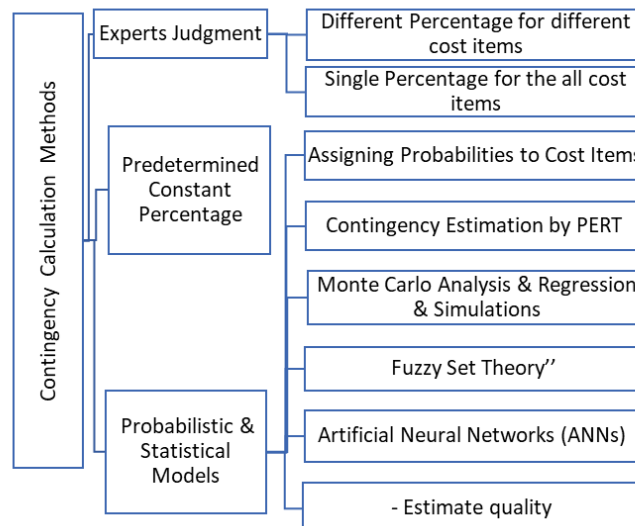


Fig (b): Contingency estimation methods or models classified

#### 1.4 Summary of this research

This thesis discussed the prediction of the ratio of increase in the cost of construction projects using risk management, where 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:

- 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.

- Determining the probability of occurrence of each risk factor:

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, as the survey was distributed to contracting companies in the Arab Republic of Egypt, Kingdom of Saudi Arabia, United Arab Emirates, Republic of Cyprus and State of Kuwait. (The survey was explained in Chapter ... page No. ...)

- Determining the rate of increase in the cost of project

To achieve this objective, I conducted a field study aimed in its second part to find out the rate of increase in the cost of construction projects in the event of a risk occurrence, as the survey was distributed to contracting companies in the Arab Republic of Egypt, Kingdom of Saudi Arabia, United Arab Emirates, Republic of Cyprus and State of Kuwait.



The results of the paper 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.

1.4.1 Regarding 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.

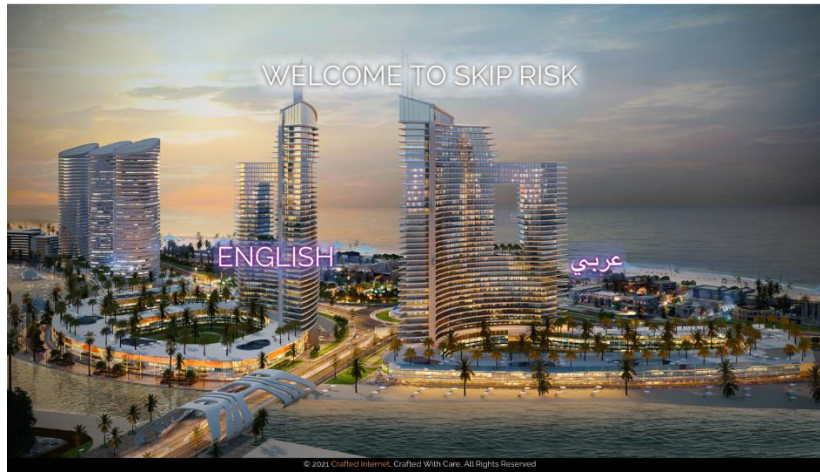
3. With regard to the type of projects on which the responses of the companies participating in the survey relied, there were 58 contractors, representing 43.6%, stated that the projects on which their responses relied were government projects and private projects, while 41 contractors, representing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

1.4.2 Developing a program that can predict the rate of increasing in the cost of project:

None of the contracting companies in which those responsible for estimating costs have been interviewed have any mathematical model or program for estimating the cost of emergencies and they use a rate or depend on their intuition and experience in estimating the percentage of contingencies, there are several reasons for this, perhaps the most important of which is that the recognized technologies are very complex and difficult to deal with, or they need courses in accredited centers for training on this type of technology,

so the idea of the program came to be simple and accessible to everyone and keep pace with the great development in technology so that the contractor can download the program in its Arabic and English versions via a computer or a smartphone and review the risks that may be faced in the project and then determine which of these risks he may face, accordingly, the program performs a simple calculation process, the result of which shall be the rate of increase in the cost of project based on the inputs, whereas once the program is opened, the language options will appear to the browser, and once the language is selected, the program's tools will be introduced by reviewing the 71 risks that depend of the second part of the survey, After selecting the items that may be face the user, the program performs a simple calculation that shows in its result the final rate of increase in the cost of project As shown in the following pictures :



(c) a simple calculation that shows in its result the final rate of increase in the cost of project

Forecasting the rate of increase in the cost of project

Total Percentage: 0%

No.	Items	Risk Probability Ratio%	Rate Of Increase In The Cost Of Project%
1	Low productivity of labor	53.60	16.36
2	Labor disputes and unrest	42.60	8.52
3	The lack of skilled labor and labor's weak experience	59.00	16.16
4	Accidents at the site and labor's injuries and illnesses	46.20	9.00
5	The lack of resources (labor, equipment, Material)	55.20	18.42
6	Delay in supplying material.	59.80	22.03
7	Increased waste of materials.	54.60	17.90
8	Equipment malfunction during implementation.	53.60	15.86
9	Low productivity of equipment	51.20	15.96
10	Obtaining non-conforming quality (poor quality).	59.80	23.76
11	Defects in the implementation of works.	59.80	26.10
12	Delay in project duration.	63.00	29.53
13	Poor safety regulations and instructions during on-site implementation.	57.00	10.90
14	Some structures cracked during implementation.	41.00	19.21
15	Suspension of work	51.80	23.85
16	The lack of engineering drawings and information.	55.20	18.24
17	Errors, ambiguities, and inconsistency with project specifications.	57.20	20.11
18	Modification of designs by the owner or his representative during construction.	64.20	22.24
19	Errors in designs.	52.80	17.26
20	Difficulty and complexity in designs and hence difficulty in construction and implementation.	56.60	19.46
21	Delay in the delivery of detailed drawings.	58.40	16.65
22	Loss due to price inflation (increasing the prices of materials, labor, equipment, ... etc.).	60.20	21.16

23	Depreciation of the local currency and fluctuation of exchange rates	53.20	17.06
24	Cost overrun from on planned cost	56.00	21.12
25	Delay in paying the sums owed to the contractor by the owner.	61.60	16.57
26	Liquidity problems of the contractor and the difficulty of financing the project.	60.60	14.76
27	Imposing a penalty for delay.	60.40	16.17
28	Weak communication and coordination between project parties during implementation during implementation	55.00	18.57
29	Availability of some bad features in the project management team, such as the lack of experience, inefficiency and incompatibility with the work team.	61.80	19.37
30	Inefficiency in project planning and scheduling by the contractors administration	56.40	25.92
31	The internal organization (the structural composition of the administration and the project system) is inadequate.	54.00	17.55
32	Administrative weakness in the calculation of quantities and benchmarking.	49.00	17.41
33	Delays in preparations to start work by contractor and delay or mistake in field survey work of the site.	49.40	14.02
34	Error in choosing the type and location of the project.	43.40	16.81
35	Change in project personnel during its implementation.	52.60	15.92
36	Bad accelerate of project handover using additional resources.	53.00	19.81
37	The contractor's fault in the technical study of project during the tender phase.	52.20	19.00
38	Shortage of administrative personnel of the contractor	48.00	9.45
39	Thefts at the project site.	51.40	15.84
40	Delay in delivering the site to the contractor by the owner.	48.60	9.45
41	Delayed settlement of contractors claims by the owner.	59.00	16.98
42	Suspension of project works by the owner.	52.40	19.39
43	Delayed decision making by the owner.	60.60	16.78
44	Intervention of the owner in the implementation process phases.	61.00	20.57
45	Failure of the owner to cooperate with contractor.	59.80	14.84
46	Increasing red tape procedures by the owner.	56.00	14.60
47	Changes the scope of work of project (quantities of items, new items, new areas, ... etc.) by the owner.	62.80	23.56
48	Determining short implementation period by the owner in the contract of project.	59.60	25.59

<input type="checkbox"/>	49	Poor qualifications of the supervising administrative staff.	4760	1284
<input type="checkbox"/>	50	Consultant delays in approving the contractors explanations (such as material samples, plans, schedules, requests for payment of extracts ... etc.).	5240	1502
<input type="checkbox"/>	51	Consultant delays in performing the necessary checks and tests.	5600	1062
<input type="checkbox"/>	52	Conflict between the contractor and the consultant during the construction phase.	5720	1259
<input type="checkbox"/>	53	The lack of the credibility of subcontractors	6160	1672
<input type="checkbox"/>	54	Shortage of subcontractors.	5420	1293
<input type="checkbox"/>	55	Problems between the subcontractor and the main contractor.	5480	1246
<input type="checkbox"/>	56	Liquidity problems of subcontractors	6040	1458
<input type="checkbox"/>	57	The change and difference in the condition of site (entrance of site, neighboring infrastructure, buildings around the site, etc.).	4980	1128
<input type="checkbox"/>	58	The lack of utilities (electricity, water, gas, etc.)	4740	2082
<input type="checkbox"/>	59	The effect of underground conditions (different soil composition, presence of public utilities, high water table, etc.).	5360	1754
<input type="checkbox"/>	60	Difficulty of accessing the site.	4360	1648
<input type="checkbox"/>	61	The influence of social conditions and traditions.	4160	762
<input type="checkbox"/>	62	The effect of extreme weather conditions in the project area (the effect of extreme hot or cold weather, increased rain, wind and sandstorms, etc.)	4720	1117
<input type="checkbox"/>	63	Incidence Floods and torrents	4140	1369
<input type="checkbox"/>	64	Incidence Earthquakes	3720	1859
<input type="checkbox"/>	65	Incidence Volcanoes	3160	1895
<input type="checkbox"/>	66	Incidence A fire occurred at the site	4740	2072
<input type="checkbox"/>	67	Delay in obtaining legal rights	5220	1285
<input type="checkbox"/>	68	Legal disputes between the parties involved in the project	5060	1406
<input type="checkbox"/>	69	Difficulty and restrictions in obtaining work permits from the concerned authorities	5540	1434
<input type="checkbox"/>	70	Changes in laws and regulations (taxes, employment, trade, ... etc.)	4920	1415
<input type="checkbox"/>	71	Loss as a result of war, civil turmoil, revolution, popular turmoil, etc.)	4820	3047

Total Percentage: 0%

Table( 1)forecasting the rate of increase in the cost of project



## 1.4.3 model to measuring Program effectiveness

After performing the program and activating it, we had to make a model through which we could verify the effectiveness of the program that we did by setting up a model that compares the completed project with that by reviewing the project data during the bid submission to win the tender and after the actual implementation of the project and looking at The feasibility of the program, as it was agreed with one of the contractors to provide us with project data whose actual value exceeded 100 million Egyptian pounds during the past few years. Dropping the project clauses (71) used to create the program and accordingly it became clear to us the following:

## 1.4.3.1 General information

- Type of project: Residential
- Location of the project : Egypt – AL-alamein city
- Total cost of the project: submitted during bidding (114,500,000)
- The time period of the project: The project was implemented within the prescribed time period for the project
- The currency used in the project is Egyptian pounds

## 1.4.3.2 Dropping the eleven groups ( 71 risks ) on the program

- As for the special clauses included in the program under study, the results were as follows:
- With regard to the risks associated with Construction and JobSite Risk Factors :
- There were many risks to the contractor it is Clause 4,7.
- in Clause 4, accidents at the site and workers' injuries led to the increase of financial clause that amounted to 130,500 Egyptian pounds knowing that the project was implemented during the period before Corona until the beginning of the second wave at the end of December 2020.

- While in item 7, which includes Increased waste of materials.
- through the final budget of the project, it became clear that there is a wastage whose value was estimated at 650,000 Egyptian pounds, and this item is also related to item No. 62, which is The effect of extreme weather conditions in the project area (the effect of extreme hot or cold weather, increased rain, wind and sandstorms, etc.) and item 63 of the Incidence Floods and torrents.

- Regarding to the risks associated with the designs, there were no problems encountered by the contractor in these items

- Regarding to the risks associated with the Financial and Economic Risk Factors: -

the contractor faced several difficulties led to an increase in the cost of the project, namely clause 22, where the Loss due to price inflation (price increases for materials, workers, equipment, ... etc.). led to an increase in this clause, which reached 1,480,000 Egyptian pounds

- With regard to the risks associated with management, there were no problems except item 39 Which is Thefts at the project site. Where the site was robbed by some people and the amount of the material they robbed is 975,000 Egyptian pounds

- Regarding the risks associated with the owner, there were no problems
- Regarding the risks associated with the consultant, there were no problems
- Regarding the problems related to subcontractors, item No. 53, where the lack of credibility of the subcontractors during the implementation of some of the works entrusted to him led to major problems that necessitated returning some items, which led to an increase in the cost of the item amounting to 805,000 Egyptian pounds

- Regarding the risks related to Site Conditions : The contractor was affected by item No. 59, where the effect of underground conditions (different soil composition, presence of public utilities, high water table, etc.) . through the final budget of the project, Where the contractor faced major problems related to this item It led to an increase in the cost of this implementing the item amounted to 391,000 Egyptian pounds .In addition, there is Clause No. 61, which is represented in the impact of social conditions and traditions, where the contractor was forced to pay royalties to the Bedouins surrounding the site, exceeding 650,000 Egyptian pounds .in exchange for protection or something similar.

- Regarding the risks associated with weather factors and variables, there were no problems
- Regarding the risks associated with legal affairs, there were no problems
- Regarding risks associated with government actions or policy, there were no risks
- Based on the above mentioned information and with a simple arithmetic operation, it becomes clear to us that the total increase in the cost of the project was 5,082,000 Egyptian pound

- while the total cost of the project according to the bid submitted before opening the envelopes was 114,500,000, so that it becomes clear to us that the percentage increase in the cost of the project was 4,43% .

- While the rate of increase in the cost of the project over the planned was according to the application is 8.7%



#### IV. CONCLUSION

Every human endeavor or action carries with it many risks. Also, no project is free from risks and therefore the situation is getting worse for contractors due to the competitive environment. In general, these risks can directly affect the costs, quality and duration of the project. The purpose of estimating emergency costs in construction projects using risk management technique is to help companies working in the field of construction to correctly estimate the cost of the project before submitting the bid in a sound scientific manner, in addition to avoiding any sudden increase in the project cost. During its implementation, which may lead to large losses. Therefore, the purpose of this research is to develop a model or program that works to identify emergency cases during the bidding phase of projects and to estimate the percentage of the expected increase in the project cost.

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