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RISK ANALYSIS OF CONSTRUCTION SECTOR IN EGYPT (DURING THE ECONOMIC RECESSION PERIODS)

Shahenda EL-Matbaegy[1], Moataz Khalil,[2] Tarek Sharaf[3] and Mohamed EL-Gandour[4]

ABSTRACT

The construction industry is a significant part of the Egyptian economy. In real terms, the Egyptian construction industry registered growth during the review period (2011–2015) and expected to continue to expand over the forecast period (2016–2020), with investments in residential, infrastructure, energy and utilities construction projects. Forecast-period growth will drive by government efforts to develop the country's rail and road infrastructure and meet its energy targets by 2022. But currently, Egypt's economy is suffering from a shortage of foreign currency reserves and liquidity, leading the country's central bank to float the Egyptian pound's value, which has subsequently risen from 8.88 to 18 pounds per US dollar (a 100% increase), a recession started. Hence, the performance of the construction industry is affected by national economies. The aim of this study is to develop appropriate risk model to mitigate recession effect on construction industry in Egypt.

Methodology of the following study based on identifying the potential risks in construction projects under recession period, characterizing their probability and impacts, performing the quantitative and qualitative risk analysis (based on questionaries' survey conducted in the year 2015/2016), and statistical analysis by (SPSS) has been carried out to develop risks' model and measurement framework using the Primavera Risk Analysis (V8) Software. Focusing in various project's size and type (small, large, private, and governmental projects). The results show that the corruption associated with recession is the most aspect of risks affecting the Egyptian construction sector during recession periods in addition risks that related to poorly sector participants management abilities.

KEYWORDS: Recession - Egyptian construction sector - Risk model - Mitigation measures framework - SPSS - Primavera risk analysis.

1.1. Introduction

Recession is perceived as an international phenomenon since Global Financial Crisis 2008, which is considered by many economists to have been the worst financial crisis since the Great Depression of the 1930s [1]. The National Bureau of Economic Research (NIBER) defined a recession as "a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in a real gross domestic product (GDP), real income, employment, industrial production and whole sale-retail sales. While, many Economists have defined recession as a negative real GDP growth rate for two consecutive quarters [2].

Gross domestic product is the best way to measure a country's economy. GDP is the total value of everything produced by all the people and companies in the country. Based on the percentage growth of GDP index, Figure 1 (issued by the Center for Information and Decision Support Center of the Egyptian Cabinet) that displays the development in national income. Economic had witnessed several recession periods since 1980, it comes to be worst after 25th January 2011 revolution.

A recession is perceived as a general downturn associated with high unemployment, slowing Gross Domestic /Product (GDP), and high inflation [3][4].

The construction industry is a mirror of the Egyptian economy health, employing 11% of total employment in 2015/2016 with a workforce of 2.7 million people. It is one of the major contributing sectors to employment in Egypt, after the agricultural sector. Additional to that, the Egyptian construction industry accounts for 4.8 percent of the national GDP on 2015/2016.

On other hand, more than 90 industries have linked directly to the construction sector such as but not limited of manufacturing, suppliers, engineering, and real estate marketing companies [5]. The recovery of construction sector very important engine of growth in the national economy. On the other hand, an infinite influence of the economic indicates real risks affecting the construction industry [6].

Hence, from the nature of the sector and the current economic situation, emerges the need to help the Egyptian construction sector to overcome the economic crisis, that harsh period consequently emerges the research question:

What is the potential risks that affecting the Egyptian construction sector during recession periods?

[2]*Business Development Manager, PetroJet Company,E- mail:motzkhalil@gmai*

[3]*Assistant Professor,Faculty of Engineering, Civil Engineering Department, Po*

[4]*Professor of Steel Structure, Faculty of Engineering, Civil Engineering Department, Port Said University,E- mail:dr.elghandor@gmail.com*

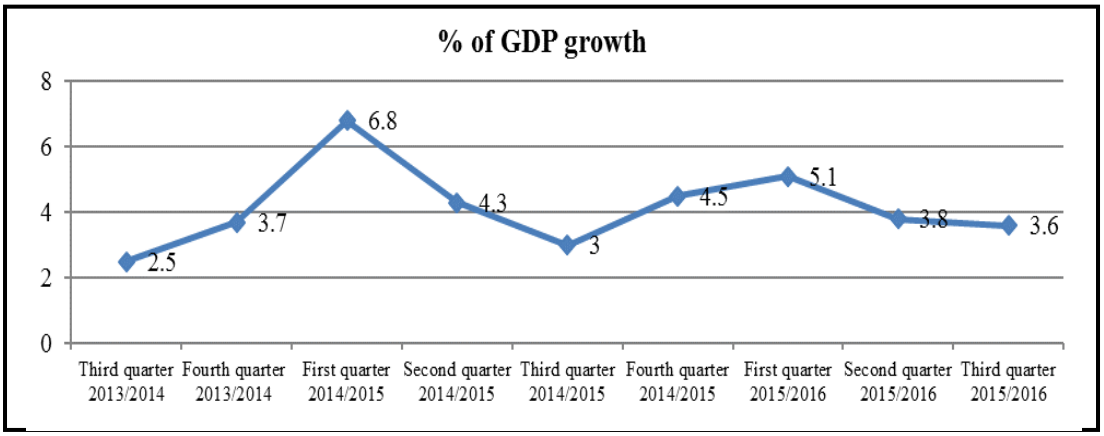


Figure 1: Percentage growth of GDP index (quarter refers to three months).

The objectives of this paper is to identify and formulate the potential risk factors, which related the recession period and influencing the construction industry. In addition, identifying the contrast between the industry stakeholders (owner, and contractor's). Analyzing the variances in each side' vision regarding the potential risk factors, probability of occurrence, level of impact, and recommended response plans, Performing qualitative risk analysis using the interviews with industry experts and formulate their assessment of the risk probability and Impact. Where, the main aim of paper is to extract risks with high priority to create Risk-Model as well extract measures with high priority to create Measures- Framework, performing three case studies for difference nature projects using Primavera risk's management software, and quantitative risk analysis tools and techniques to develop risk modeling to identify the overall risk impact on project's objectives.

2. Literature review

2.1. Concept of risk

In many studies, risk definitions were concerned to that related to the construction process as (Faber, 1979) [7] described risk according its negative impact "the likelihood of occurrence of a definite event/factor or combination of events/factors which occur during the whole process of construction to the detriment of the project".

(Bufaid et al, 1987) [8] Defined risks with the term uncertainty "a consideration in the process of a construction project whose variation results in uncertainty in the final cost, duration and quality of the project". Moreover, International Standard IEC 62198: 2001 [9] defined risk according to its characteristics " a combined of probability of an event occurring and its consequences for project objectives". While, the current study examines mainly the negative impact of risks inherent in construction projects through a combined consideration of probability of occurrence and the magnitude of impact.

2.2. Identified risks

Actual, many survey studies published in Egypt analyzing risks and its impact on the project objectives. (Issa, 2012) [10] Indicate poor definition of stakeholder's roles and responsibilities. Moreover, poor communication (coordination) between various parties. Additionally, (Marzouk, 2014) [11] perceived that the delay dues financial issues have occupied the highest ranking in projects delay risk factors. While, (Hafez et al, 2014) [12] identified the risk factors affecting the labors productivity as that construction managers lack of leadership skills, climate, and site layout. Moreover, (Abdul-Rashid, 2007) [13] concluded that the low safety awareness of the company top management resulted in lack of Safety systems implementation. Finally, (Khodeir et al. 2014) [14] proved that political and economic situation after January, 2011 revolution have an adversary impact in construction sector.

Finally, interviews with experts had been held in federation of the Egyptian construction & building contractors. A structured questionnaire - during the year 2015/2016- designed to reflect the risks mainly expected due the recession environment. Identified risks classified into direct and indirect risks according to their degree of dependence on recession environment during the research period 2015/2016. Direct risk factors include the fluctuation of material prices, high competitiveness, low funding, political uncertainty, corruption, and new projects' interruption due to recession period. On the other hand, indirect risks seen that the risks that have a dependence on the direct risks of the recession. Where, the delay of dues payment direct attributed to current economic situation. Payments from owners are the main source of revenue for construction contractors. When owners delay payments to contractors, a financial hardship placed on the contractors. Additionally, government urgently seeks to impose

or increase taxation as an endeavor to face current situation. Consequently, this risk increase in taxes adversely affects the project stakeholders' funding. Political uncertainty includes the changes of legislations and laws governing the process of building construction while, the government is interested in making political stability. Consequently, there is a lack of oriented policy to develop the construction industry. Moreover, stakeholders' corruption due their personal financial problems and lack of work stability lead to poor performance, less productivity, lack of loyalty, and worst work environment. In additional, lack of quality confidence between owners, and contractors. Awarding tenders to the lowest price neglecting the proper contractors' selection criteria.

Finally, from the literature study of factors influencing the construction process performance, several factors have been selected which are broadly classified under eight categories; *Technical, Quality, Legal, Political, Ethics, Safety, Administration, and Financial factors.*

3. Methodology

Interviews with industry experts' are adopted as the main research method in this study. The research starts with identifying the factors which related to the recession period and expected to effect on the construction industry, design the questionnaire, conduct interviews, research data validation, risk assessment, case studies analysis, develop the risk model, and plan the recommended risk responses measures.

3.1. Questionnaire design

The first questionnaire designed for accurately assaying main characteristics of risk factor impact, probability and allocation. In the same lines, the second questionnaire designed to assay the degree of effectiveness for risks measures. For this purpose, questionnaires have built mainly in a closed-ended question because it is easy to ask and quick to answer, it requires no writing by either respondent or interviewer, and its analysis is straightforward. Moreover, the questionnaire has divided in to three parts: the first part is the respondent profile, the second is the risk factor characteristics or the degree of effectiveness for risks measures and the third is a qualitative question of the respondents' conception on risk definition. A pilot study has conducted on forty respondents to verify the questionnaire validity. Where, a pilot study provides a trial run for the questionnaire, which involves testing the wording of the question, identifying ambiguous questions, testing the technique that the researcher uses to collect the data, measuring the effectiveness of the standard invitation to respondents, etc. [15].

3.1.1. Research Validation

Validity refers to questionnaires accuracy and ability to measure what is the researcher intended to study. High validity refer to that collected data is free of prejudices and common entry errors. When a questionnaires data is valid, it truly reflects the concept, which the researcher supposed to measure [16]. Validity has a number of different aspects and assessment approaches. Below several routes to evaluate the research validity that adopted in the current study:

Content validity
Construct validity

3.1.1.1. Content Validation

Content validity refers to the success of researchers in creating measurement items that cover the content domain of the variable being measured [17]. A high degree of content validity has ensured in this study by the extensive review of questionnaires and interviews structure by an expert as well as comparing and referring to the literature available in the area of the study. To ensure the appropriateness of the research questionnaires, Content Validity Index (CVI) has determined that refers to the degree to which the questionnaire actually measures or it has specifically related to the traits for which it has designed. The content validity index has established at 0.848, which has considered high enough.

3.1.1.2. Construct validity

For construct validity, Field [18] suggested factor analysis of determination method. Factor analysis is accomplished when a single factor is extracted from the questionnaire variables for each test as well is shown to be valid as a construct. Communalities that represent the relation between the variable and all other variables (i.e., the squared multiple correlation between the item and all other items) before rotation should exceed 0.5, which is accepted to indicate validity of a construct's measure [19]. As seen in details, Figure 2 represents a Scree Plot graphic, which guides to the number of the essential factorial axes (factors) determination. Extraction of factors relies mainly on eigenvalues, (i.e represent the relative importance of each factor in accounting for variance associated with the set of variables being analyze) that should exceed 1. Eigenvalues (a measure of explained variance) should exceed 1.0, which is a common criterion for factor usefulness. When the eigenvalue is less than 1.0 the factor explains less information than a single item would have explained. Thus, the eigenvalues of the five factors, as perceived in Table 2, (8.98, 6.48, 2.15, 1.896, 1.25) for the 1st, 2nd, 3th, up to 5th, respectively) which the test mainly relies on to decide whether they interpret data in a satisfactory way or not. As perceived in Table 1, factors variances summation exceeds 70%, which reflects a good fit of the questionnaire (instrument) construct as an initial step. In addition, by reviewing Table 1, which represents communality table for the values of the average variance

extracted from the main risks and measures groups of the questionnaire categories. The values exceeded the 0.5 index, which has accepted to indicate validity of a construct measure.

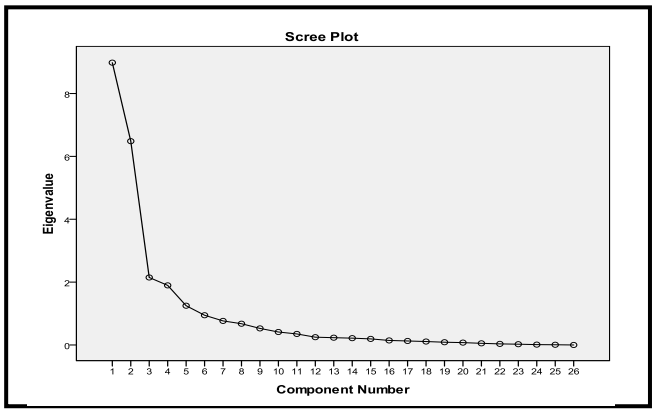


Figure 2: Scree Plot

Component	Eigen values	Cumulative %		Extraction
1	6.484	34.5	Technical-impact	.931
2	2.147	59.4	Quality-impact	.544
3	1.896	67.7	Political-impact	.735
4	1.249	75.0	Financial-impact	.809
5	.946	79.8	Administrative impact	.821
6	.765	83.4	Ethics impact	.760
7	.676	86.4	Legal impact	.806
8	.527	89.0	Safety impact	.733
9	.412	91.0	Technical probability	.829
10	.351	92.6	Quality probability	.825
11	.248	93.9	Political probability	.825
12	.232	94.9	Financial probability	.859
13	.217	95.8	Administrative	.862
14	.193	96.6	Ethic probability	.824
15	.144	97.4	Legal probability	.851
16	.087	97.9	Safety probability	.809
17	.075	99.2	Technical measures	.907
18	.052	99.5	Quality measures	.861
19	.035	99.7	Political measures	.921
20	.024	99.8	Financial measures	.638
21	.011	99.9	Administrative	.806
22	.007	99.9	Ethics measures	.800
23	-	100.	Legal measures	.788
24	8.982	100	Safety measures	.518

Table 1: Validity test output.

3.2. Internal consistency analysis

To ensure questionnaires reliability, Cronbach's coefficient alpha has used to test the internal consistency among the items included in each factor. Nunnally [20] has recommended that a minimum of 0.7 is sufficient. Factor reliability has measured by calculating Cronbach's for all factors. As perceived Cronbach's factor is 0.98 that exceeded .7. This value has been at an acceptable level, making all factors reliable.

3.3. Measurement scale

In order to be able to select an appropriate method of analysis, the level of measurement must be understood. It occurs in a variety of forms. One of the most common item scales is called a Likert scale. The Likert scale is commonly using to measure opinions, beliefs and attitudes. Where, the respondents' perceptions have to convert to numeric quantitative means [21]. When a Likert scale has to be used, the item is presenting as a declarative sentence, followed by response options that indicate varying degrees of agreement with or endorsement of the statement. Here the respondents' opinions or perceptions have been dividing as very low impact or probability to very high impact or probability for risk as well divided as very low of effectiveness to very high of effectiveness as perceived in Table 2. Since, its degree of each perception has its represented number. Consequently, respondents assess the perceptions for each questionnaire factor, which has converted to its rating number. The mean average for each factor has computed according to the specific numbers that associated with the degree of perceptions.

Symbol	The degree of economic impact	The degree of probability	Degree of effectiveness
1	Very low	Very low	Very low
2	Low	Low	Low
3	Moderate	Moderate	Moderate
4	High	High	High
5	Very high	Very high	Very high

Table 2: Rating system for risk criticality and mitigation measure effectiveness

3.4. Case studies

Three case studies are adopting in the current study to reflect all projects circumstances in Egypt. Interviews conducted with projects managers to discuss the risks that confront their projects in the recession period. Identifying, and evaluating critical risks. The most critical risks (Risk Model) from lifecycle have quantified statistically with the aid of PRIMAVERA® risk analysis (ver. 8).

3.5. Research population

A population consists of the total of the observations, in which the research was concerned. Two different parties targeted in this research, construction projects owners and their representatives including consultants, and the second party represents by the contractors companies.

Sample size

The size of the sample required from the population has been determined based on statistical principles for this type of exploratory investigation

to reflect a confidence level of 99%. The sample size was determined using the following equation [22]:

$$N=\frac{(Z_{1-\alpha})^2\times\sigma^2}{e^2} \quad \text{..... (1)}$$

Where: N is the sample size, $Z_{1-\alpha}$ is the desired level of confidence (1-α), which determines the critical Z value,σ is the standard deviation, and e is the acceptable sampling error. For this research, the 99% degree confidence level corresponds to α= 0.01. Each of the shaded tails shown in the standard normal distribution curve, Figure 3 has an area of α/2 = 0.005. The region is 0.5 – 0.005 equal to 0.495. Then, from the table of the standard normal distribution (z), an area of 0.495 corresponds to a z value of 2.58. The critical value is therefore $Z_{1-\alpha}$ equal to 2.58, the margin of error has assumed as e = 0.20, and from a 40 random samples, the standard deviation has calculated; equal to 1.096. Substituting the values in equation (1) above, the sample size has calculated as 200. This means that the minimum sample required is 200 from the population to reach 99% confidence level.

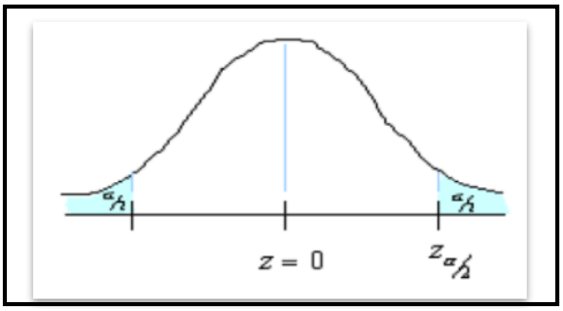


Figure 3 standard normal distribution curve

3.6. Approach of analyses

The adopted process to prioritizing risks for further analysis as discussed by [23], [24] assessing and combining their probability of occurrence and impact. Which identified risks that's requires performing qualitative risk analysis and risk modeling.

The following study survey targeted to classify the observations into three categories. Interviews conducted separately with owners, contractors, and companied meeting with both of them.

Results compared together, and analyzed using ANOVA statistical test, T-test and Chi-Square test techniques to rank the research measures, and identify the contrast between the industry stakeholders (owner, and contractor's). Analyzing the variances in each side' vision regarding the potential risk factors, probability of occurrence, level of impact, and recommended response plans.

Many studies [25][26] have relied on a subjective assumption to allocate risk factors by specifying a minimum response rate. This paper, in addition to the subjective assumption, we added an objective assessment for risk allocation with the use of the cross tab Chi-square test. Therefore, we consider two condition have to fulfill to consider any risk factor allocation in this study: (1) there is at least a 50% response rate in that category (the subjective assessment); and (2) the difference in response rates between the three categories is statistically significant.

4. Results

4.1. contrast analysis

The ANOVA test used in this study to assess the mean differences between owners or consultants and contractors vision by evaluating the level of variation between responses. The purpose is to dedicate whether the analysis of the collected data from each side will carried out separately or not.

4.1.1. Contrast analysis in risk impact assessment:

Figure (4) shows ANOVA variances between the owners' representatives and contractors' risk impact assessment –we can see clear contrast in two risk's categories. That all P-values of the categories are less 0.05, except for the P-value of the quality and political categories.

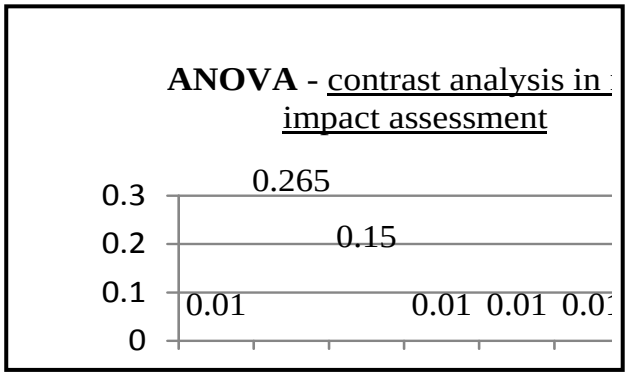


Figure 4 Categories negative impact comparison

4.1.2. contrast analysis in risk probability assessment:

Figure (5) shows that all P-values of the categories are less 0.05, except for the P-value of the technical, quality and financial categories (P = .093, 0.932 and .375 > 0.05).

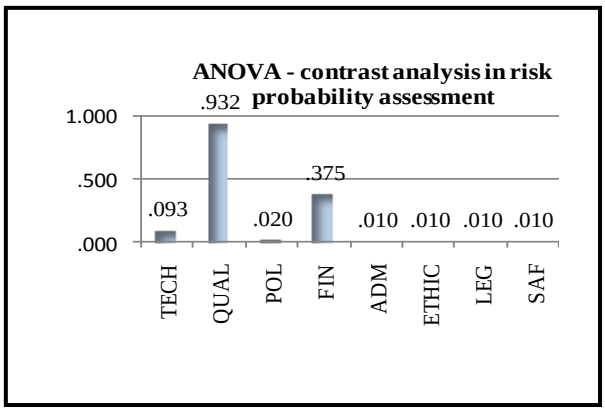


Figure 5 Categories likelihood of occurrence.

4.1.3. contrast analysis in response plans

Figure (6), that Sig < 0.05, which implies that the variances between the Average values of the collected data from (owners and contractors) are statistically significant.

Because of that, the analysis of the data from owners and contractors' perception carried out separately. Where, significance difference (Sig.) refers to the degree of confidence based on 5% (0.05) error.

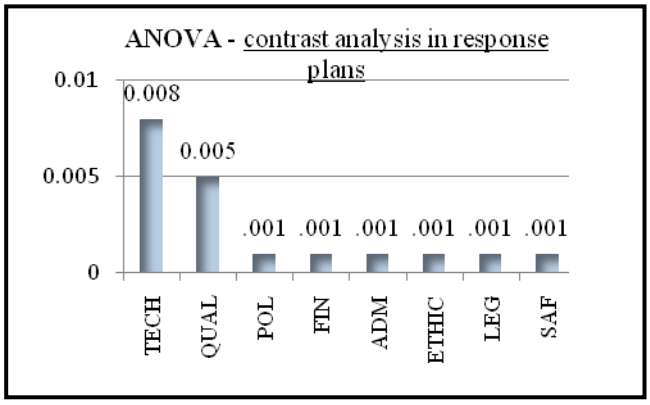


Figure 6 Categories degree of effectiveness.

4.2. Perform Qualitative Risk Analysis.

4.2.1. Probability and Impact Assessment

Questionnaires survey conducted with experts to perform qualitative risk analysis help us to develop clear assessments of the risk probability and impact level. Survey parties vision is identical and Top factors filtered for further analysis. T-test utilized to identify the risk factors impact and probability as illustrated in Table (3), (4) showing the Egyptian risk factors negative impact during recession period.

The level of impact illustrated in Table (3) showing those owners' representatives and contractors has agreed that recession period risk factor "Current economic situation" is the highest impact on construction sector in Egypt. Moreover, to other risk factors that considered as a part of the recession period outcomes as a Bribes, Cronyism, and corruption. Additional to the well-known risk factors in construction industry as communication, coordination, lack of management thought and labors productivity.

The probability assessment illustrates in Table (4) showing those owners' representative and contractors agreed that recession period, and currency floating is considered as Risk triggers for many risks' occurrence and started as risk event already. Moreover, the risk factors, which related to the recession period assessed with very high probability of occurrence level.

3.3. Risk Model

Risks prioritized for further quantitative analysis and planning risk responses based on their risk rating. Ratings assigned to risks based on their assessed probability and impact. Evaluation of each risk's importance and priority for attention typically conducted using a look-up table or a probability and impact matrix. Such a matrix specifies combinations of probability and impact that lead to rating the risks as low, moderate, or high priority. Numeric values can be used as the result of multiplication of impact and probability of each risk. Table (5) illustrates the Risk Model developed during this paper questionaries' survey.

3.4. Recommended Response Plans

Critical risk factors identification based on the study variable (recession period) and assessment of their probability and impact level is an important issue to develop the set of options or action to reduce threads to the projects objectives. Recommended response plans to avoid or mitigate the construction industry influence due to the recession period is an urgent demand.

Risk response plans adapted by an organizations' risk attitude. Therefore, contrast responses expected from whose owners, and contractors' representatives. Chi-Squire test utilized to identify the risk response plans as illustrated in Table (6) showing the Egyptian measures (Response plans) framework during recession period.

RF	Owners' perspective		Contractors'		Sign.
Bribes on projects delivery	5	1			0.00*
Lack of management thought	4.83	2			0.00*
Awarding tenders to lowest prices	4.83	3			0.00*
Cronyism and corruption on awarding tenders	4.83	4	4.25	4	0.00*
Cheating materials specification	4.83	5			0.00*
Current economic situation	4.67	6	4.17	8	0.00*
Ease of sector entry	4.67	7			0.00*
Poor Projects distribution between large and small	4.67	8			0.00*
Burn bid prices during tenders	4.67	9			0.00*
Several design mistakes	4.67	10			0.00*
Lack of site data			4.44	1	.187
Ownerbankruptcy			4.4	2	.255
Corruption and bribery of governments officials			4.3	3	0.00*
Pricing mistakes			4.21	5	.324
Lack of experienced designers			4.19	6	0.00*
Un safe site location			4.19	7	0.041*
Inflation impact on material prices			4.16	9	0.00*
Execution mistakes			4.16	10	.418

Table 3 Level of impact in top ten risk.

RF	Owners' perspective		Contractors' perspective		Sign.
	Mean	Rank	Mean	Rank	
Courts length during contracts parties	4.83	1	4.12	2	0.00*
Awarding tenders to lowest prices	4.83	2			0.00*
Ease of sector entry	4.83	3			0.00*
Cronyism and corruption on awarding tenders	4.83	4	3.95	8	0.00*
Burn bid prices during tenders	4.83	5			0.00*
Bribes on projects delivery	4.83	6	4.06	4	0.00*
Poor Projects distribution between large and	4.67	7	4.02	5	0.00*
Drawings delay	4.50	8			.526
Projects sizes less than participants	4.50	9			0.00*
Authority relationship with construction	4.50	10			0.00*
Current economic situation	4.29	1			.821
Corruption and bribery of governments	4.10	3			0.00*
Lack of safety systems	3.97	6			.005*
Political uncertainty	3.95	7			.903
Inappropriate planning pre tenders	3.95	9			0.00*
Foreign investment obstacles	3.90	10			.568

Table 4 Level of probability in top ten risks

Risks Model	Contractor (RI)	Owner (RI)
Bribes on projects delivery	16.4	24.2
Cronyism and corruption in awarding tenders	16.3	23.4
Awarding tenders to lowest prices	15.4	23.4
Ease of sector entry		22.6
Burn bid prices during tenders	15	22.6
Courts length during contracts parties litigations		21.8
Poor projects distribution between large and small firms	15.4	21.8
Current economic situation	17.6	21
Lack of management thought		20.9
Government impact on litigations		20.2
Contractors falsification in classifications documents		20.2
Cheating material specifications		20.1
Egyptian arbitration chamber is not activated		19.5
Lack of specialized courts		19.5
Authority relationship with construction sector	14.9	19.5
Difficulty in issuing permits		19.4
Weakness of Data base		18.8
Conflict in design drawings		18.8
Poor in project risks allocations (responsibilities)	15.2	18.8
Lack of scientific management	15	18.8
Lack of governmental oriented policy to develop construction sector	14.5	18.8
Political uncertainty	16.4	
Lack of safety systems	16.2	
Criminal behavior	16	
Execution mistakes	15.8	
Tolerance quality on delivery	15.4	
The absence of technical department	15.2	
contractual problems	14.7	
Drawings delay	14.7	
Lack of site data	14.7	
Inflation impact on material prices	14.6	

Table 5 Research risk model

Measurement framework	Contractor	Owner
Consultant delivers the drawings on time.	4.08	4.83
Pay dues to contractor on time		4.68
Rely on contractor with high administrative skills.	4.08	4.68
Improve legislative system		4.60
Enact legislation requires refused tenders less than the estimation value with 25%.	4.06	4.52
The government fix exchange rate		4.52
Prepare and submit all necessary documents and feasibility on timely manner	4.09	4.52
Unite the prime minister and the finance ministry to facilitate the projects capital		4.52
Prepare and submit all necessary documents and feasibility		4.47
Secure a standby cash flow		4.47
Define clearly the objectives of all project		4.47
Employ the professional project management team		4.47
Create legal and reasonable measures to reduce taxes		4.44
Project team must be aware of the		4.44
Rely on distinct contractors in the technical		4.39
Contractor obliged to Project specifications, schedule to reduce conflicts		4.39
Add clauses of disputes settlements in the contract		4.39
Add clauses in the contract relating to additional expenses , inflation		4.39
Obtain approvals and permits in a timely manner to avoid the workflow obstruction	4.14	4.39
Keep good relations with relevant officials and senior officials	4.07	
Enforce fines by the competent authorities in case the owner delay in dues payment	4.10	
The design team must be cautious to carry out soil tests and all site tests	4.14	
Rely on the experienced managers to take out a good schedule	4.15	
Set clauses in the contract including inflation and delay rates	4.16	
Cooperation design team and the consultant engineer to minimize the change in the design	4.16	
A scientific skilled project team should be set at the initiating of the project	4.16	
Add risks to the schedule	4.19	
Owner must prepare a practical schedule	4.32	
Measure BOQ properly during tender	4.33	
Rely on distinct contractors in the technical field	4.37	
Transfer and sharing risk with a third-party	4.40	

Table 6: Research measures (Response Plans) framework

3.5. Risk Allocation

Risk allocation refers to assignment the roles and responsibilities with a possible risks' avoidance, or mitigation plans. Moreover, clarify the contract parties' responsibility for any future loss caused by unexpected risk triggers especially that risks which related to the government regulations, political, and economic crisis as Egypt's current recession period, currency floating, and the greater prices fluctuations. Consequently, risk allocation is an important step in risk mitigation [33]. Where, the current situation demonstrates the need of share the failure responsibility between stakeholders from contractors, and owners' representatives particularly to avoid disputes.

Table (7) demonstrates how the contract parties should allocate the risk accordance to the questionnaires survey with industry experts. As perceived, owner and contractor tended to similarly responses in risk allocation. Except five risk responses were different. "Manipulating the tendering prices" on behalf of owner the risk actually undecided despite it has been expected to be on contractor shoulder. On the other hand, contractor allocated the risk on himself but he hoped to share it.

Risk	*Owner*		*Contractor*	
	Observed	*Expected*	*Observed*	*Expected*
Authority relationship	Undecided	Undecided	Undecided	Undecided
Sector entry	Owner	Owner	Owner	Owner
Courts length	Undecided	Undecided	Undecided	Undecided
Management thought	Undecided	Undecided	Undecided	Undecided
Government & disputes	Undecided	Undecided	Undecided	Undecided
Contractors falsification	Undecided	Undecided	Undecided	Undecided
Specifications cheating	Shared	Shared	Contractor	Contractor
Settlement committees	Shared	Shared	Shared	Shared
Load prices	Undecided	Contractor	Contractor	Shared
Issuing permits	Owner	Owner	Shared	Shared
Database	Shared	Shared	Contractor	Contractor
Design drawings	Undecided	Undecided	Owner	Owner
Economic situation	Undecided	Undecided	Undecided	Undecided
Corruption & bribery	Shared	Shared	Shared	Shared
Political decisions	Undecided	Undecided	Undecided	Undecided
Delivery bribes	Shared	Shared	Shared	Shared
Political instabilities	Shared	Shared	Shared	Shared
Cronyism in tenders	Shared	Shared	Owner	Shared
Safety systems	Undecided	Undecided	Undecided	Undecided
Thefts and crime	Shared	Shared	Shared	Shared
Execution mistakes	Contractor	Contractor	Contractor	Shared
Tenders adoption	Owner	Owner	Owner	Owner
Quality tolerance	Owner	Owner	Owner	Owner
Technical department	Shared	Shared	Undecided	Owner
Ill project management	Undecided	Undecided	Undecided	Undecided
Scientific management	Undecided	Undecided	Undecided	Undecided
Burn bids	Shared	Shared	Contractor	Contractor
Authority relationship	Shared	Owner	Contractor	Shared
Subcontractor management	Undecided	Undecided	Undecided	Undecided
Contractual problems	Shared	Shared	Shared	Shared
Drawings delivery	Owner	Owner	Owner	Owner
Site data	Contractor	Owner	Shared	Owner
Inflation	Undecided	Undecided	Shared	Shared
Country policy	Undecided	Undecided	Undecided	Undecided

Table 7: Actual and expected risk model allocation according to stakeholders' perspective

4. Quantitative Risk Analysis

4.1. Case Studies

Where the majors' risk factors identified, and qualitative assessment of their probability and impact matrix performed. Furthermore, quantitative risk analysis addressed in this paper to provide numerically analyzing the effect of identified risks on overall project objectives.

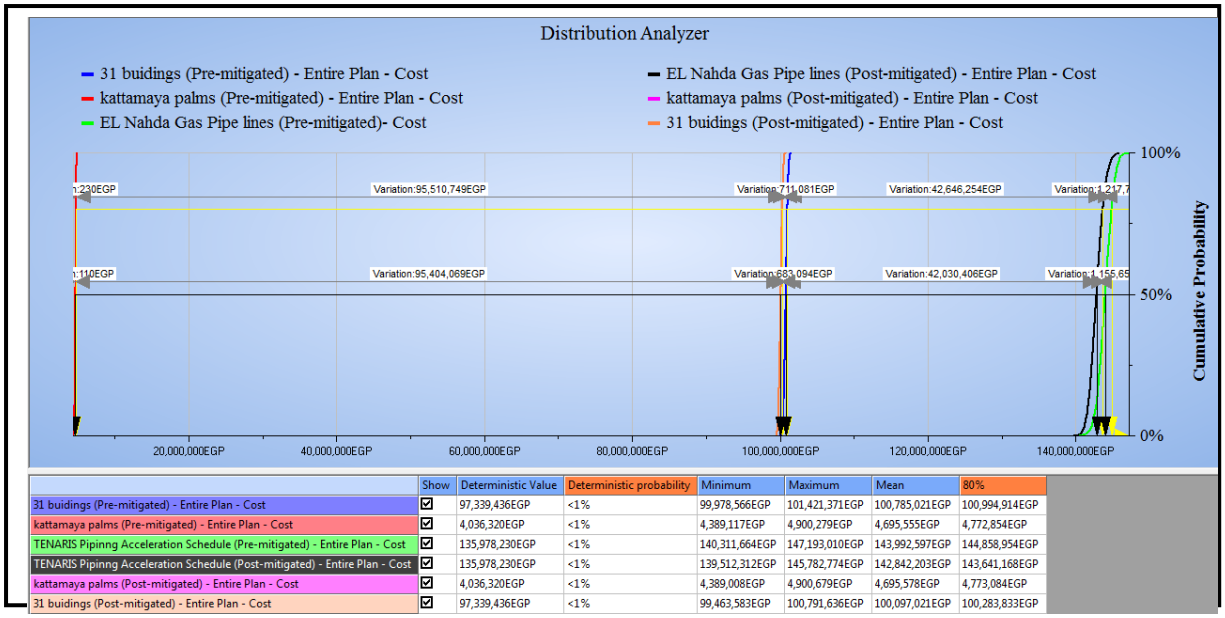
Three real life projects selected as case studies to perform quantitative risk analysis. The selection criteria adopted by verity of the projects' type, size, and private or government sector to reflect Egypt construction sector environment as the following:

1. Project A: KATTAMEYA Palms Project Small – Private
2. Project B: EL NAHDA Cement Factory Large – Private
3. Project C: EL Hussein Youth Housing Government

Case studies Inputs includes the projects' contract documents, baseline schedule, budget cost allocation, and the assessed risk factors caricaturized in this research.

It allows building task uncertainties (three point estimates for task duration and cost) and projecting risks (Risk Model identified risk factors) into a Primavera P6 schedule. These variances applied to the project plan and simulated with 'Monte Carlo' risk analysis [27]. Which demonstrates the chance of project completion on deterministic time and budgeted cost. Identify required contingency reserve [Expected monetary value] to achieve desired level of uncertainty. Whereas, these case studies adopted desired level of uncertainty 80%, no project succeeded to conduct its budget and time as his baseline scheduled. Figure (7) showing the three projects cost estimation values. Moreover, Table (8) represents the major outputs of the three case studies.

For project manager, it is very helpful to take decisions based on information that shows completion cost and its associated probability rather than using only information of estimated cost. Contractor must set aside budget to overcome the exceeded scheduled cost and time [28]. The percentage of side budget to deterministic budget is 13.6% for small projects, 4.3% for governmental projects and 8.4 % for large projects.



	Show	Deterministic Value	Deterministic probability	Minimum	Maximum	Mean	80%
31 buidings (Pre-mitigated) - Entire Plan - Cost	☑	97,339,436EGP	<1%	99,978,566EGP	101,421,371EGP	100,785,021EGP	100,994,914EGP
kattamaya palms (Pre-mitigated) - Entire Plan - Cost	☑	4,036,320EGP	<1%	4,389,117EGP	4,900,279EGP	4,695,555EGP	4,772,854EGP
TENARIS Pipinng Acceleration Schedule (Pre-mitigated) - Entire Plan - Cost	☑	135,978,230EGP	<1%	140,311,664EGP	147,193,010EGP	143,992,597EGP	144,858,954EGP
TENARIS Pipinng Acceleration Schedule (Post-mitigated) - Entire Plan - Cost	☑	135,978,230EGP	<1%	139,512,312EGP	145,782,774EGP	142,842,203EGP	143,641,168EGP
kattamaya palms (Post-mitigated) - Entire Plan - Cost	☑	4,036,320EGP	<1%	4,389,008EGP	4,900,679EGP	4,695,578EGP	4,773,084EGP
31 buidings (Post-mitigated) - Entire Plan - Cost	☑	97,339,436EGP	<1%	99,463,583EGP	100,791,636EGP	100,097,021EGP	100,283,833EGP

Figure 7: S curve of the Three project cost estimation values.

Tools and techniques involve analysis carried out with the aid of primavera risk analysis, and Monte Carlo Analysis. Outputs, A project simulation uses a model that translates cost uncertainties into their potential impact on project objectives' time and cost wise.

Primavera Risk Analysis is an 'add-on' module to Primavera P6. Primavera Risk Analysis integrates directly with project schedules and cost estimates to provide quick and easy techniques to model risks and analyze the cost and schedule impacts of mitigating them.

As perceived in Table (8), the proper mitigation measures reduced the whole projects cost for small, large and governmental projects by 11.9%, 3.3% and 1.4% respectively, that reflects the importance of risk management in achieving project objectives It has seen that "Material cost fluctuation" occupied highest risk impact in the three projects. Where, "Lack in management thought" has perceived as the second critical risk factor. Moreover, "The Cronyism and Corruption in contract awarding process" perceived as most critical risk in the governmental projects. Finally, the current economic situation and the lack of oriented policies to develop the sector have perceived the most

critical aspects of the risks affecting the construction sector in Egypt during recession periods.

Variable	Kattameya (small project)	El Nahda factory (large)	31 building (governmental)
Percentage of estimation cost due to Pre mitigation cost	21.3%	7.8%	4%
Percentage of estimation cost due to Post mitigation cost	9.4%	4.5%	2.6%
Saved cost	11.9%	3.3%	1.4%
Side	13.6%	8.4%	4.3%
Critical risks	1- Design drawing	1- Economic situation	1-Inflation
	2- Burn bids	2- Political decisions	2-Sector entry
	3- Tolerance quality	3- Authority relationship	3- Cronyism and corruption
	4- Awarding tenders	4- Issuing permits	4- Design mistakes
	5- Site data	5- Inflation	5- Load other tender items
	6- Inflation	6- Corruption and bribery	6- Delivery bribes
	7- Sector entry	7- Skilled managers	7- Dues delay
	8- Dues delay	8- Scientific management	8- Burn bid
	9- Safety systems	9- End joint contracts	9- Sub contractor management
	10- Profit margins	10- Country interest	10- Budget confidence

Table 8: Primavera risk analysis output for the adopted projects

5. Risk definition according respondents' perception

One part of the questionnaire was designed to identify risk definition according to both contractor and owner' perspective. The respondents requested to give a risk definition in their own words. Moreover, exploring their vision regarding the risk management objectives to avoid negative impacts only or there is an opportunities behind some risks. Results, Only about 33% (25 respondents) and 60% (75 respondents) of the owner and contractor, respectively, responded that the risk management objective is only to avoid, mitigate, or transfer the negative risk impact on project objectives. Other respondents "66% (50 owners) and 40% (50 contractors)" showing clear understanding for probable opportunities in risk management. The results reflect more risk management awareness in owner representatives' side. The results have indicated as depicted in Figure (8).

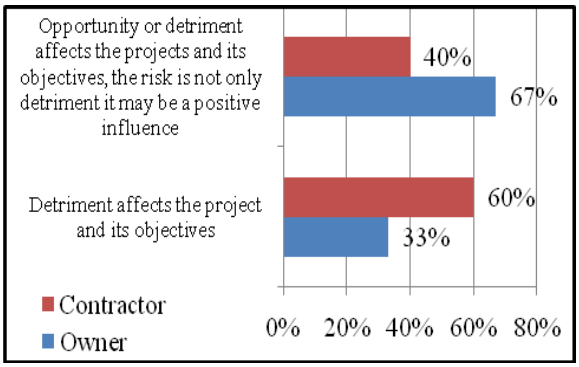


Figure 8: Definition of risk according respondents' perspectives.

6. Correlations of risk factors

Correlation defined as a coefficient that represent the association between two variables. It is the degree which two variables sharing a common relationship [29]. Correlation coefficient that identify the degree of interdependence between risk factors with each other. Where high correlation coefficient shows risk factors that leads to other factors appearance, consider it as the root cause to other risks and deserve the priority for further analysis and developing risk response plans. The highest correlations coefficient between identified risk factors considered in this study as the Sector Critical Criteria. Table (9) shows the correlation coefficient of identified risks that represent the degree of interdependence between risk factors with each other in the level of impact assessment. Table (10) represent the correlation coefficient related to the probability of occurrence assessment.

7. Conclusion

Where the construction industry is a significant part of our economy, and based on the current economic recession in Egypt 2015-2016, that research had adopted to identify the potential risk factors and studying their impact on this sector in the coming years. A questionnaires and interviews with industry experts held to identify the potential risk factors, assessing their probability of occurrence and level of impact, and collect the recommended risk response plans. Moreover, surveying awareness and contrast of the industry stakeholders regarding the risk definition, objectives, assessment, and risk response plans. Case studies

through three of real construction projects to provide numerical analysis of the risks' probability and impact level on the projects objectives as Time, and Cost. It can be concluded that:-

- As shown in risk model based on the responses of the survey, the owners and contractors have perceived risks management during the recession period occupied an advanced priority. Economic situation, corruption, and political uncertainty that indicates its serious impact on construction industry in Egypt.
- In general, the respondents were consistent in deciding the risks that contractors should share it. However, it has found that presently many risks have unclear decided to be allocated on government involvement as well the respondents possessed different perceptions pertaining to the owner's risks. The contractors expected that the owners would readily bear more risks.
- Top critical risks that carried out for further analysis through the case studies. Hence, no project had succeeded to conduct its cost and time as a plan scheduled. Contractor must set aside budget to overcome the exceeded scheduled cost and time. The percentage of side budget to deterministic budget is 13.6% for small projects, 4.3% for governmental projects and 8.4 % for large projects.
- From the case studies results, we find out those different projects types' shows different risk factors. Contractors could use the Case studies' outputs, or he could apply corrective mitigation actions towards the identified list of risk factors using several mitigations actions suggested in this study.
- It has observed that technical risks usually affect the small projects. Governmental projects have affected by the procedures of tenders and their consequent on the project parties. Large projects have most affected by the policies of the government representatives.
- General it has been seen the corruption associated with recession is the most aspect of risks affecting the Egyptian construction sector during recession periods in addition risks that related to poorly sector participants abilities
- Recommendations based on results of measures framework shows the government's role in the development of construction sector and the issuance of suitable legislation considered as a comprehensive solution.

	Sector entry	Court's length	Management thought	Government impact	Contractors falsification	Cheating specifications	Dispute settelement	Economic situation	Corruption and bribes	Cronyism and corruption	Awarding tenders	Tolerance quality
Sector entry											0.7	0.6
Burn bid	0.7			0.6			0.6					
Project	0.7											
Tolerance quality											0.6	
Awarding tenders								0.6		0.6		
Criminal behavior									0.7			
Delivery bribes					0.6	0.7						
Design drawings		0.7										
Data base		0.6	0.6									
Load other tender				0.6								
Contractors			0.6									
Government		0.6										
Management		0.6										

Table 9: Highly correlations in impact between risk factors model.

	Authority relationship	Burn bid	Modern techniques	Execution mistakes	Cronyism and bribes	Corruption and bribery	Design drawings	Data base	Issuing permits	Load other tender item	Government impact	Courts length
Oriented policy	0.8			0.7								
Site data										0.7		
Contractual problems			0.7									
Authority relationship		0.7									0.7	
Burn bid					0.7					0.8	0.7	
Scientific management							0.7	0.7				
Modern techniques												0.7
Criminal bahavior						0.7						
Design drawings									0.7			0.7
Data base												0.7
Issuing permits										0.7		
Load other tender											0.7	
Government impact												0.7

Table 10: Highly correlations in probability between risk factors model.

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