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Risk Response Planning for Top Risks Affecting Schedule and Cost of Mega Construction Projects in EGYPT

[(1)]Amr Afifi Abdul Hamed, [(2)]Adel Abo El-yazid El-samadony,
[(3)]Ahmed Mohammed Abdelalim

[1]PHD Candidate Faculty of Engineering at Mataria , Helwan University, Cairo, Egypt .
Email: Eng.amrafifi@Hotmail.com

*Corresponding author

[2]Professor of Construction Management, faculty of engineering at Mataria, Helwan University, Cairo, Egypt.
Email:A.Samadony@epmcon.com

[3]Associate professor of construction Engineering and Project Management, faculty of engineering at Mataria, Helwan University, Cairo, Egypt . Email: Dr.ahmed.abdelalim@gmail.com

Abstract: **Risk management in construction industry is one of the important processes of construction management to achieve project objectives and minimize potential risks . Construction projects have been distinguished from other projects in different industries by their uniqueness and complexity. Many types of construction industry in EGYPT were studied such as infrastructure, public buildings, housing projects and power station projects, these kinds of projects have a huge development due the increasing demand for such kind . Risk factors affecting negatively this industry are attributed to many sources as these risks cause cost overrun and/or schedule delay in many construction projects. As per PMBOK 2018 , plan risk Responses is the process of developing options, selecting strategies, and agreeing on actions to address overall project risk exposure, as well as to treat individual project risks. The key benefit of this process is that it identifies appropriate ways to address overall project risk and individual project risks.**

The purpose of this research is to achieve and propose an integrated and coherent risk response approach to improve and develop risk management processes , mitigate threats , maximize response influence , alerting & advising stake holders to insure project success and overcome obstacles with the lowest expected losses .

In the main research many steps were conducted starting by literature review , identifying the risk factors and sources using extensive survey through experts representing huge companies in construction fields . Then an a questionnaire was designed & distributed to prioritize these factors regarding their probability and consequences on both time and cost. According to their relative important index , a statistical analysis for all collected data was carried out using (Statistical Package for the Social Sciences) SPSS Ver.23 software . In parallel an extensive survey was conducted to collect data of 32 real existing mega projects during last ten years with a total budget of 330 billion EGP. These data includes real indications , impacts and deviations regarding the main parameters adopted in this research , time & cost , then a forecasting model was developed using Crystal Ball software ver. 11.1.2.4 , the entire range of results possible for a given situation with a specified confidence levels by studying the top 20 risk factors affecting time and cost and their impacts on the case studies of projects with the highest schedule and cost deviations . Finally, a survey was distributed to experts to identify the most effective responses for these risks. The result was adding 78 new responses by the respondents beside the original questionnaire 80 responses .

Keywords: **Risk assessment , qualitative , quantitative , schedule deviation , cost deviation , probability, impact , relative important index , response planning , simulation , forecasting , statistical analysis.**

1. GENERAL INTRODUCTION

The construction industry is one of the most dynamic, risky, challenging and strict. Construction projects are particularly subjected to more risks than other ones, because of their complexity, various components, inputs, outputs, financial problems and conflicts among parties. Moreover, they require many people with different skills, using equipment, applying many technologies and the coordination of wide range of activities.

Moreover, there are many types of construction industry in EGYPT, some of these types will be studied deeply in this research. These types of projects like infrastructure (Roads, Bridges, & Waste water treatment plants), public buildings (Airports , Banks, Malls & Religious buildings), housing projects (Hotels, Compounds & Resorts) and power projects (Power Plant, Solar plant, Oil & Gas plants), industry has a huge flourishment and development in EGYPT as the important need for these projects to increase investments and to continue improvement plans.

Unexpected increase in cost and delays in construction projects are caused by owners, contractors, environments, etc. in which several types of risk factors may occur concurrently. The effect of cost overrun and schedule delay do not only influence the construction industry but the overall economy as well. **(A. M.Abdel-Alim, et.al 2017)**

There are many sources of uncertainty in construction projects, which include the performance of construction parties, resources availability, environmental conditions, involvement of other parties, contractual relations, etc. As a result of these sources, construction projects may face problems **(Faridi and El-Sayegh 2006)**.

These factors have led the construction industry to seek alternative strategies to mitigate negative risks & minimize their consequences and exploit opportunities & maximize their consequences. Risks causes cost overrun and/or schedule delay in many construction projects. In addition, risks can affect productivity, performance, quality and scope of construction projects.

Risk response planning is one of the main phases in the project risk management and has major impacts on the success of a large-scale project. Since projects are unique, and risks are dynamic through the life of the projects, it is necessary to formulate responses of the important risks.

2. PROBLEM DEFINITIONS

In construction projects there are many risk sources and factors affect projects success and objectives , many researchers studied construction risks in EGYPT in all its related processes starting from risk identification till risk monitoring . But in this paper we need to reveal a wide view and focus on a complete methodology for risk response planning for top risks affecting schedule and cost of mega construction projects in EGYPT by conducting extensive meetings , surveys and questionnaires to extract real data which will help in complete an applicable method for managing these risks . Also , depending on real case studies and huge existing projects this research will reveal an important results which will help in managing risks smoothly and propose responses effectively .

2.1Gaps in the literature

After reviewing many previous researches , few of them were focusing on a complete methodology for managing risks , as some focus on only risk identification , others focus on using expert systems for response planning and many of researches conducted only one survey / questionnaire to enhance their data collection . In this research three questionnaire were distributed to an experts with a high managerial levels in huge construction companies in EGYPT , many soft wares were used to examine and analyze the collected data , ending by proposing a variety of real and effective risk response strategies .

2.2 Research Objectives

The research aims to many objectives which may summarized as follow :

- Construct a general risk register that includes the most frequent risks facing the construction contractors using heuristic data gathering.
- Based on the probability of occurrence and impact of each risk, ranking is conducted using qualitative risk assessment techniques. The purpose of ranking is to highlight the risky areas and obtain the priority list of project risks.

- Assess the methods of risk identification techniques in construction industry.
- Setting up a well-defined risk profile, qualitative & quantitative assessment.
- Conducting an extensive survey for 32 real existing projects constructed during past 15 years to study and analyze any schedule or cost deviations , reasons .
- Setting up a clear and effective responses planning .

3. LITERATURE REVIEW

Many different approaches to risk classification have been recommended in the literature (Tah & Carr, 2001); (Zavadskas, Turskis, & Tamosaitiene, 2010); (El-sayegh, 2008); (Baloi & Price, 2003). Review of the literature shows that there is a lack of an accepted method of risk classification among professionals in the construction industry. Zayed, et al., (2008) suggested a hierarchy level of classification based on macro and micro levels . Also A detailed risk source level classification is suggested by Elsayegh (2008) as outlined in Figure 1. While figure 2 shows the risks classification suggested by Baloi and Price (2003). It is also usual to classify project risks into sets of classifications like dynamic/static, corporate/individual, internal/external, positive/ negative, acceptable /unacceptable and insurable/non-insurable (Baloi & Price, 2003) .

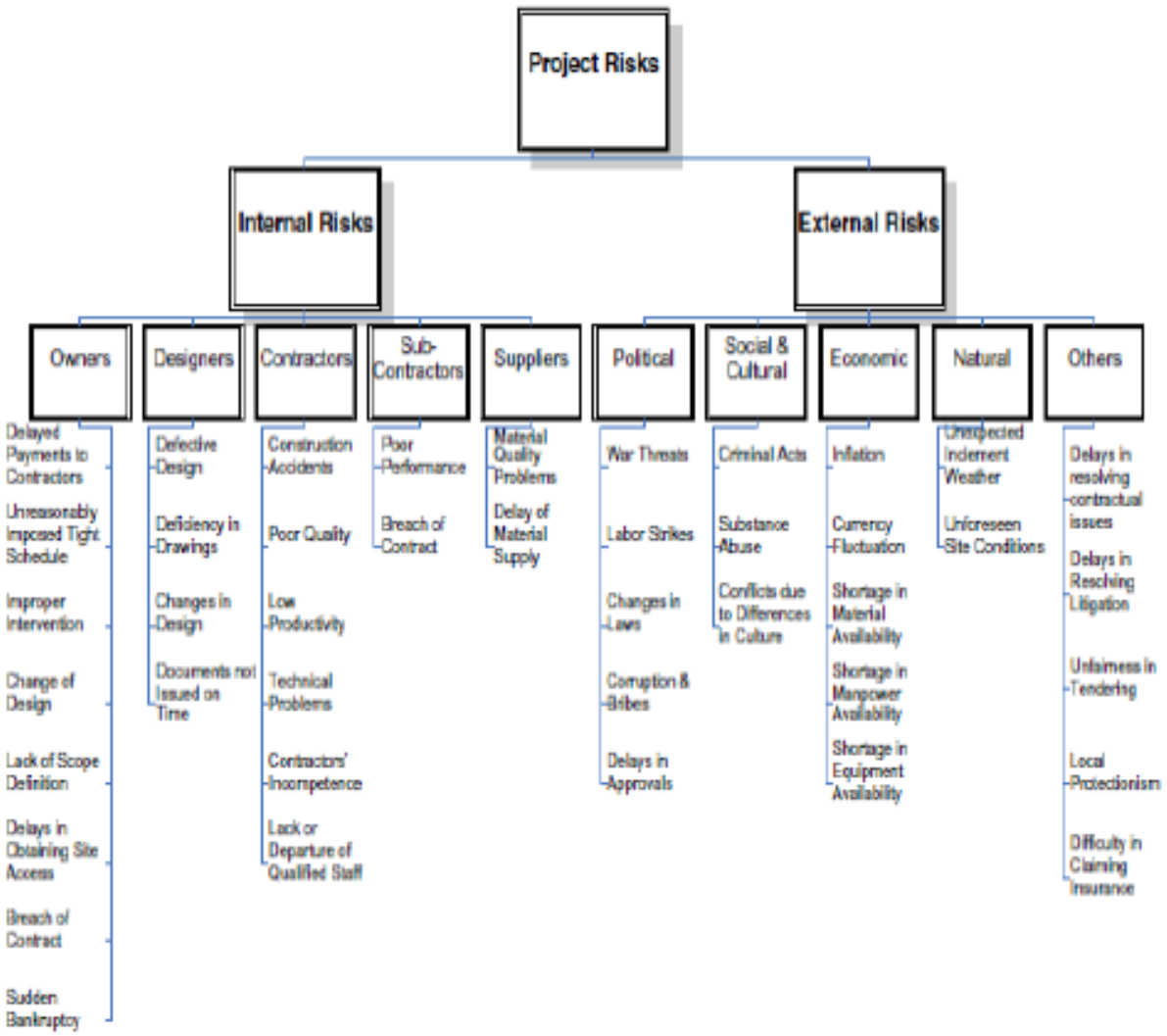


Figure 1: Risk Classification by Source of Risk ((El-sayegh, 2008)

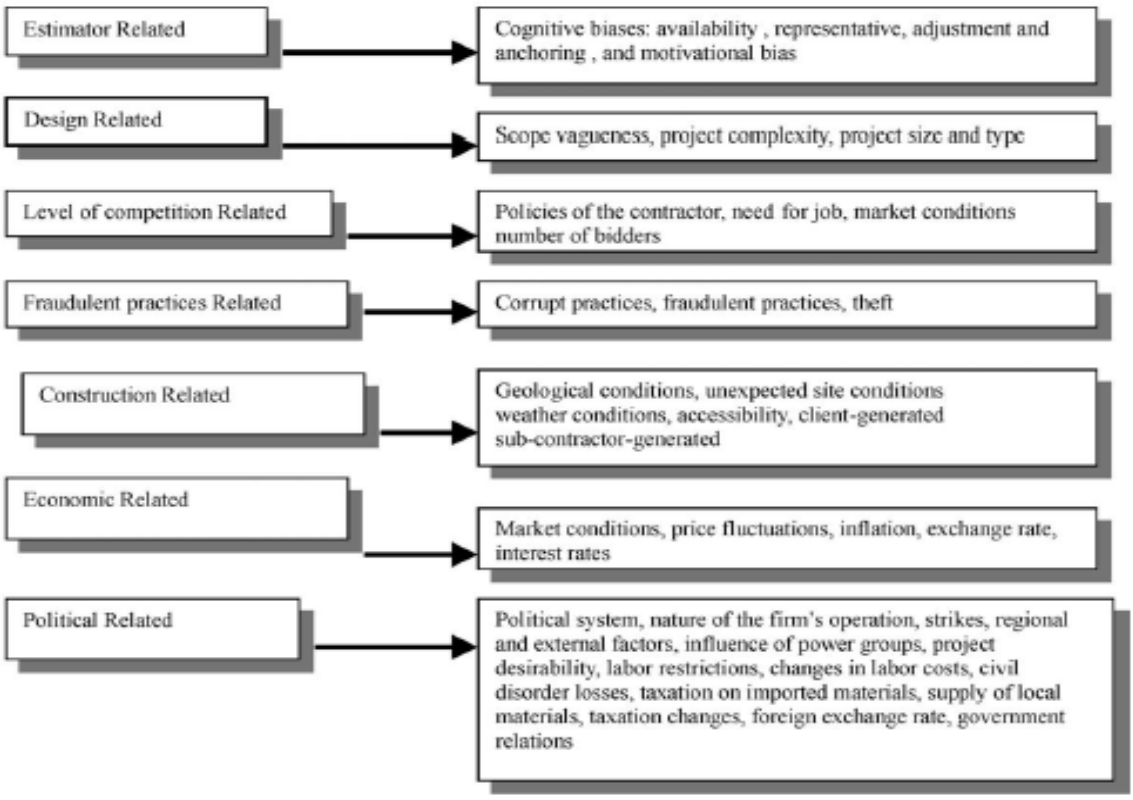


Figure 2: Main Classification of Global Risks (Baloi & Price, 2003)

However, Tah and Carr (2001) suggested a two level hierarchy classification of project risks. The two levels are external and internal risks. Flanagan and Norman suggested three ways of classifying risk: based on consequence, type, and impact of risk. Chapman (2006) grouped risks into four subsets (environment, industry, client and project). Shen-fa and Xiao (2009) classified project risks 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.

Another classification of project risk is pure risk versus speculative risk. Pure risk involves situations that can only end in a loss. For example, the risk of an accident or earthquake is a pure risk. Speculative risks on the other hand are situations that might end in a loss or a gain. For example, the risks of change in exchange rate or scope change are speculative risks. Speculative risks are dynamic and changing while pure risks are more static due to their nature. Insurance deals with only pure risks and not speculative risks.

Regarding Egyptian studies , (A. M. Abdelalim 2019) summarized the ranking of the most important risk factors affecting construction projects in Egypt due to recent researching works . He conducted several articles which discussed the causes of risk and delays in construction projects; some studies identified the main causes of risk and ranked them, while other studies discussed the analysis methods and the proposed ways to mitigate them. Studies in Egypt were incorporated in this study to compile a list of risk factors. (Amer 1994), studied the major delay causes for construction projects which they are: poor contract management, unrealistic scheduling, lack of owner's financing/payment for completing work, design modifications during construction, and shortages in materials such as cement and steel. Abd El-Razek 2008, considered several delay causes in construction projects in Egypt as; financing by the contractor during construction, delays in contractor's payment by the owner, design changes by owner or his agent during construction, partial payments during construction, and non-utilization of professional construction/contract management. Marzouk 2014, stated that Finance and payments of completed work by owner, variation orders of scope by the owner during construction, effects of subsurface conditions, Low productivity level of labors and Ineffective planning and scheduling of the project were the most five delay causes of construction projects in Egypt. Aziz 2013 ranked factors perceived to affect delays factors and according to their importance level on delay, especially in the last decade. The data were analyzed using Relative Importance Index (RII) and the most important factors were: Delay in progress payments (Funding problems), Different tactical patterns for bribes, Shortage of equipment, Ineffective project planning and scheduling, poor

site management and supervision. Khodir 2015, identified the latest top major risk probabilities in construction projects in Egypt, according to political and economic variables between the time period Jan 2011 and Jan 2013 and then suggested a group of risk response strategies that suit each of the identified key risks. Currency price changes, new tax rates, Lack of fuel, unsecured roads, Official changes, Workers' strikes and Fire risk were the most important risk factors. Marzouk 2014, studied delays that relate to engineering factors which arise due to design development, workshop drawings, and change then he developed a knowledge based expert system for assessing the engineering related delay claims.

4. RESEARCH METHODOLOGY

Figure 3 represents the sequence of conducting research, many phases were maintained to come up with reliable results. This research demonstrates extensive literature review survey for past researches in the area of risk management in construction projects , risk definitions & types , risk identification , qualitative risk analysis , quantitative risk analysis and risk response planning & implementation .

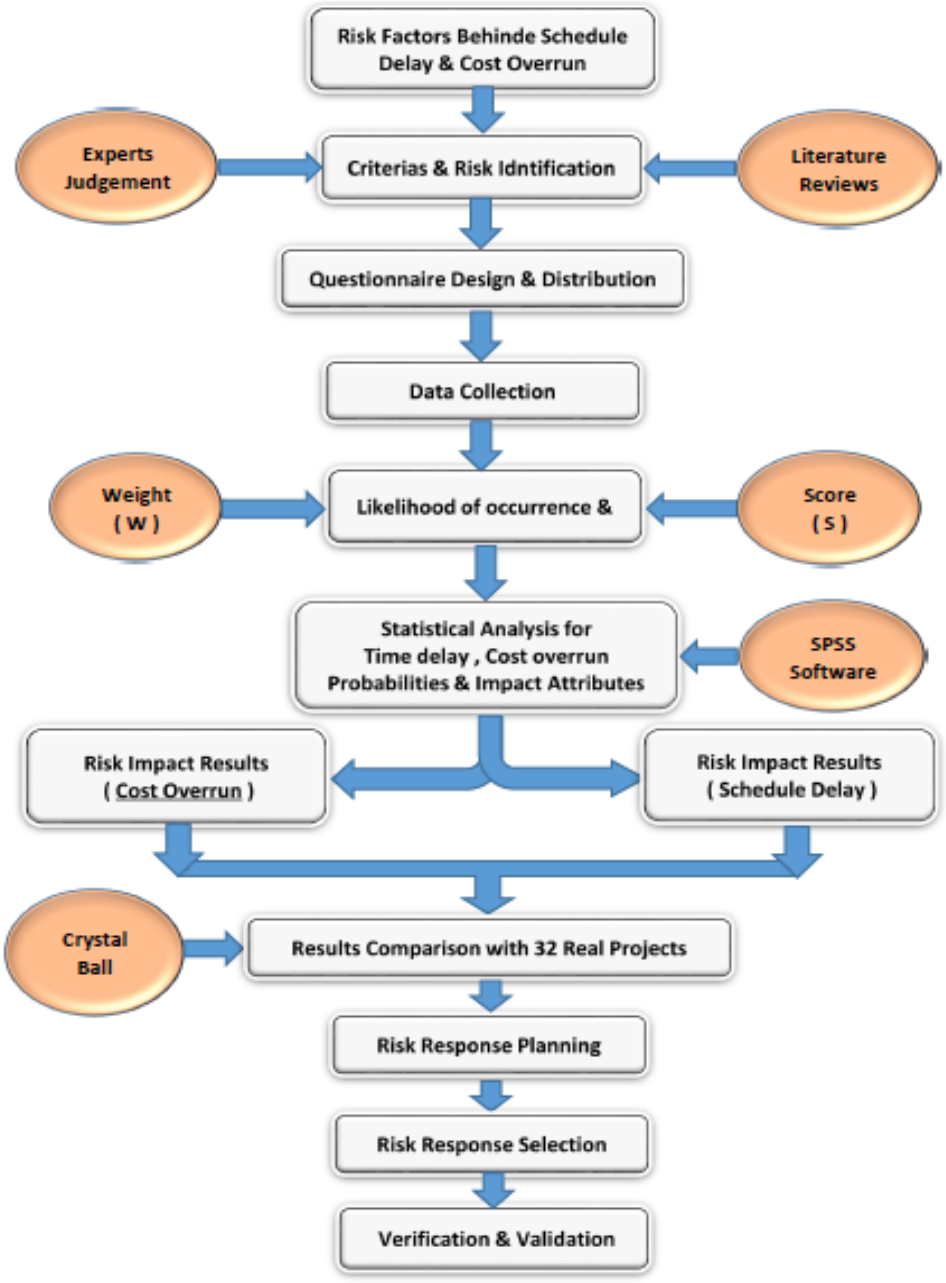


Figure 3: Research Methodology

5. RESPONSE PLANNING QUESTIONNAIRE DESIGN

As per the first part of the research paper (Proposed Methodology for Managing Risks in Construction Industry in EGYPT) a questionnaire containing the sixty-six selected attributes was developed and reviewed by 20 experts (experience more than 30 years in construction projects) to check whether the selected attributes represent all kinds of risks associated with schedule and cost overruns for large construction projects in the Egyptian environment.

The purpose of such questionnaire was to select the most important ones . During this process, the experts were encouraged to come up with new attributes that they find to be important and have great influence on schedule delay and cost overruns. New attributes have been added to the list providing they have enough potential to affect the schedule and cost overruns. Attributes that were found to be of weak or no influence were eliminated from the list contains 66 risk factors .

The survey was designed to collect the following sections :

- Risk Attribute Probability of Occurrence
- Risk Consequence on Schedule
- Risk Consequence on Cost

As a second part of the research and after determining the top 20 risk factors affecting schedule and cost , the coming step is to prepare and distribute a data collection survey and conduct interviews with high expert in construction / risk management engineers to rank and prioritize the proposed risk response strategies inserted in the questionnaire . Moreover , it will be requested from the respondents to insert any proposed strategies to be considered in the final data collection and strategies to be recommended .

The below table 1 indicates the top 20 risk factors affecting schedule as below :

Table 1:– Top 20 Risk Factors RII Affecting Schedule

Rank	Factor (Schedule Impact)	RII
1	Owner financial instability	0.884
2	Repetitive payments delay	0.87
3	Insufficient financial / funding	0.862
4	Late Material delivery	0.832
5	Un-controlled change order	0.822
6	Bad commitment to schedule	0.802
7	Unrealistic fast track schedule	0.798
8	Lack of ability and experience	0.778
9	Poor resources planning	0.77
10	Organization Weak procurement Cycle	0.762
11	Poor major equipment management plan	0.762
12	Design changes during construction	0.761
13	Labor unavailability	0.761
14	Low Equipment quality/productivity	0.756
15	Bad selection for subcontractors	0.754
16	Lack of decision making process	0.754
17	Poor Contractor pre-qualifications	0.754
18	Poor project control process	0.752
19	Unclear Project Scope Definition	0.732
20	Monetary Inflation	0.724

while table 2 indicates the top 20 risk factors affecting cost as below :

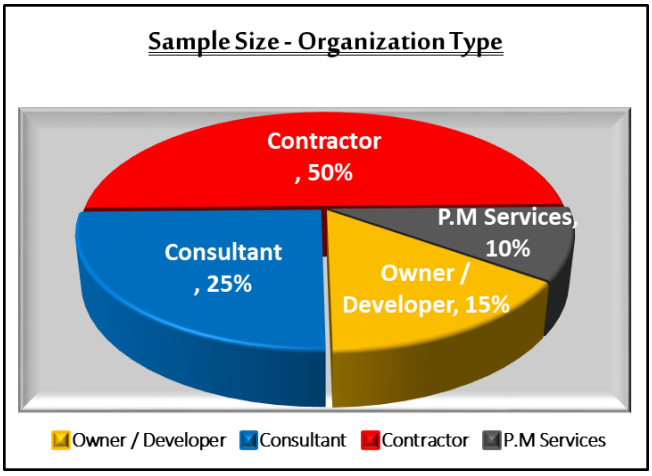
Table 2: – Top 20 Risk Factors Affecting Cost

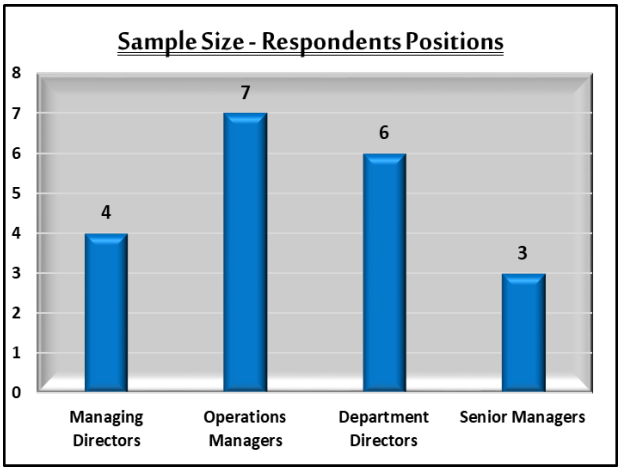
Rank	Factor (Cost Impact)	RII
1	Owner financial instability	0.898
2	Repetitive payments delay	0.886
3	Insufficient financial / funding	0.856
4	Un-controlled change order	0.838
5	Monetary Inflation	0.832
6	Material damage / waste	0.808
7	Design changes during construction	0.790
8	Poor resources planning	0.788
9	Poor Quality / Rework	0.778
10	Poor major equipment management plan	0.778
11	Poor project control process	0.776
12	Bad commitment to schedule	0.776
13	Lack of ability and experience	0.772
14	Poor labor resource planning	0.770
15	Unclear Design specifications	0.760
16	Unclear scope definition	0.756
17	Low Equipment quality/productivity	0.756
18	Organization Weak procurement Cycle	0.754
19	Bad Material storage	0.752
20	Skilled labor high wage scales	0.752

5.1 Sample Size

Some methods were adopted to determine population and sample size as there are several approaches for determining the sample size. These approaches may include (small & large population approach , using equations and applying formulas , imitating a sample size of similar studies , using published tables) .

Noting that this questionnaire will be limited to only 20 experts with at least 30 years of experience and managing more than 6 huge projects for each one of them , the respondents positions will include only construction company managing directors , operations managers , department directors & senior managers to enhance the validity and accuracy of the collected data . The below figure 4A,B illustrates the respondens profiles .





Figures 4 A,B: – Respondents Profile

5.2 Proposed Risk Response Plans for The Top 20 Schedule Risks

Many responses were proposed to the respondents for each risk factors affecting schedule , it was requested from them to choose the best responses as per their experiences which may be most effective .

Two responses for each risk are included as separate choices A,B , one choice for selecting the 2 choices A&B and last choice to add / propose any other effective responses . Table 3 includes distributed questionnaire components .

Table 3: - Strategic Response Planning for Schedule Risk Factors

Schedule Risk Factors - Strategic Response Planning	
1	**Owner financial instability**
	A) Extending the original time schedule
	B) Reducing the project scope
	C) Both of A & B
	D) Add another responses .
2	**Repetitive payments delay**
	A) Specify extension / compensation clauses in contract for payment
	B) Prepare a realistic budgeting and planning for the cash flow
	C) Both of A & B
	D) Add another responses .
3	**Insufficient financial / funding**
	A) Re-planning and budgeting of the project cash now
	B) Extending the original time schedule
	C) Both of A & B
	D) Add another responses
4	**Late Material delivery**
	A) Ensure a strong procurement management cycle to monitor materials schedule
	B) Issuing early purchasing orders for the materials
	C) Both of A & B
	D) Add another responses
5	**Un-controlled change order**
	A) Accepting change orders after adding its expected impact on the original time schedule
	B) Insure assigning good engineer / designer of the project to control these change orders
	C) Both of A & B
	D) Add another responses
6	**Bad commitment to schedule**
	A) Updating & tracking longest path of the schedule on a regular basis
	B) Assigning adequate resources to carry out planned works on time
	C) Both of A & B
	D) Add another responses .
7	**Unrealistic fast track schedule**
	A) Avoiding proceeding to tender
	B) Accept the risk as there are expected delays from other parties
	C) Both of A & B
	D) Add another responses .
8	**Lack of ability and experience**
	A) Monitor and update a list of qualified subcontractors / suppliers
	B) Ask for prequalification documents for all parties before bidding
	C) Both of A & B
	D) Add another responses .
9	**Poor resources planning**
	A) Stick with the daily planned activities according to schedule
	B) Assigning experienced and well trained staff .
	C) Both of A & B
	D) Add another responses .
10	**Organization Weak procurement Cycle**
	A) Prepare training for all low experienced staff
	B) Tracking procurement processes and assess its efficiency .
	C) Both of A & B
	D) Add another responses .
11	**Poor major equipment management plan**
	A) Assigning experienced team and out sourcing if necessary

	B) Equipment must only work on its specific job according to equipment management plan .
	C) Both of A & B
	D) Add another responses .
12	**Design changes during construction**
	A) Assigning experienced design team / consultant to avoid this risk
	B) Highlighting contractually these issues to claim for an extra time .
	C) Both of A & B
	D) Add another responses
13	**Labor unavailability**
	A) Take into consideration during preparing tender price to pay high salaries to attract labor resources
	B) Training and developing human resource team .
	C) Both of A & B
	D) Add another responses .
14	**Low Equipment quality/productivity**
	A) Preparing equipment management plans to insure proper productivity and listing more than one source of equipment
	B) Have periodical maintenance audit program .
	C) Both of A & B
	D) Add another responses
15	**Bad selection for subcontractors**
	A) Keep and update a list of qualified subcontractors & update the data base continuously
	B) Hire another subcontractor to carry out the works instead of the original one .
	C) Both of A & B
	D) Add another responses
16	**Lack of decision making process**
	A) Depend on the assigned qualified engineer decisions at most case
	B) Ensure the availability of the technical support/data for the decision maker .
	C) Both of A & B
	D) Add another responses
17	**Poor Contractor pre-qualifications**
	A) Hiring qualified contracts / subcontracts / procurement team to insure the efficiency of prequalification cycle
	B) Keep and update a list of qualified subcontractors worked on previous projects & update the data base continuously .
	C) Both of A & B
	D) Add another responses
18	**Poor project control process**
	A) Hiring qualified and experienced project control team
	B) Using newest & most applicable project control software .
	C) Both of A & B
	D) Add another responses .
19	**Unclear Project Scope & Definition**
	A) Assigning the design & specifications to a qualified party
	B) Tracking hidden points by official letters , RFI`s , even by meetings to clarify the unclear issues .
	C) Both of A & B
	D) Add another responses
20	**Monetary Inflation**
	A) Secure standby cash flow in advance - Advanced payment
	B) Sign (if applicable) long term fixed prices contracts with material suppliers .
	C) Both of A & B
	D) Add another responses

Moreover , many responses were proposed to the respondents for each risk factors affecting cost , it was requested from them to choose the best responses as per their experiences which may be most effective .

Two responses for each risk are included as separate choices A,B , one choice for selecting the 2 choices A&B and last choice to add / propose any other effective responses . Table 4 includes distributed questionnaire components .

Table 4: - Strategic Response Planning for Cost Risk Factors

Cost Risk Factors - Strategic Response Planning	
1	**Owner financial instability**
	A) Avoid tender .
	B) Reducing the project scope / specifications .
	C) Both of A & B
	D) Add another responses .
2	**Repetitive payments delay**
	A) Specify extension / compensation clauses in contract for payment .
	B) Prepare a realistic budgeting and planning for the cash flow .
	C) Both of A & B
	D) Add another responses .
3	**Insufficient financial / funding**
	A) Re-planning and budgeting of the project cash now.
	B) Extending the original time schedule .
	C) Both of A & B
	D) Add another responses .
4	**Un-controlled change order**
	A) Accepting change orders after adding its expected impact on the total cost.
	B) Insure assigning good engineer / designer of the project to control these change orders .
	C) Both of A & B
	D) Add another responses .
5	**Monetary Inflation**
	A) Secure standby cash flow in advance - Advanced payment
	B) Sign (if applicable) long term fixed prices contracts with material suppliers .
	C) Both of A & B
	D) Add another responses
6	**Material damage / waste**
	A) Taking into consideration during cost estimation .
	B) Precise monitoring for material management and good storage strategy .
	C) Both of A & B
	D) Add another responses .
7	**Design changes during construction**
	A) Assigning experienced design team / consultant to avoid this risk .
	B) Highlighting contractually these issues to claim for an extra cost .
	C) Both of A & B
	D) Add another responses .
8	**Poor resources planning**
	A) Assigning experienced planning team .
	B) Training and development for the concerned team .
	C) Both of A & B
	D) Add another responses .
9	**Poor Quality / Rework**
	A) Assigning qualified team for Q.A and Q.C with accurate inspection and testing procedure .
	B) Apply penalties for negligence that may result in defective work .
	C) Both of A & B
	D) Add another responses .
10	**Poor major equipment management plan**
	A) Assigning experienced team and out sourcing if necessary
	B) Equipment must only work on its specific job according to equipment management plan .
	C) Both of A & B
	D) Add another responses .

11	**Poor project control process**
	A) Hiring qualified and experienced project control team .
	B) Using newest & most applicable project control software .
	C) Both of A & B
	D) Add another responses .
12	**Bad commitment to schedule**
	A) Assigning adequate resources to carry out planned works on time .
	B) Updating & tracking longest path of the schedule on a regular basis
	C) Both of A & B
	D) Add another responses .
13	**Lack of ability and experience**
	A) Monitor and update a list of qualified subcontractors / suppliers
	B) Ask for prequalification documents for all parties before bidding
	C) Both of A & B
	D) Add another responses .
14	**Poor labor resource planning**
	A) Hiring expert planning staff on projects & at head office .
	B) Maintain a daily monitoring and following for all site activities .
	C) Both of A & B
	D) Add another responses .
15	**Unclear Design specifications**
	A) Hiring expert consultant to review design drawings & calculations .
	B) Have pre tender discussions via meetings and quires to reach all missing data .
	C) Both of A & B
	D) Add another responses .
16	**Unclear Project Scope Definition**
	A) Assigning the design & specifications to a qualified party
	B) Tracking hidden points by official letters , RFI`s , even by meetings to clarify the issues .
	C) Both of A & B
	D) Add another responses
17	**Low Equipment quality/productivity**
	A) Preparing equipment management plans to insure proper productivity and listing more than one source of equipment
	B) Have periodical maintenance audit program .
	C) Both of A & B
	D) Add another responses
18	**Organization Weak procurement Cycle**
	A) Prepare training for all low experienced staff
	B) Tracking procurement processes and assess its efficiency .
	C) Both of A & B
	D) Add another responses .
19	**Bad Material storage**
	A) Precise monitoring for material management and good storage strategy .
	B) Very good mobilization plan including storage facilities and audits .
	C) Both of A & B
	D) Add another responses .
20	**Skilled labor high wage scales**
	A) To be taken into consideration during preparing tender price .
	B) Trying to make bonuses & incentives related to achievements and targets.
	C) Both of A & B
	D) Add another responses .

6. APPROVED RISK RESPONSE STRATEGIES & IMPLEMENTATION

As per the questionnaire results it was designed that every risk factor have 3 choices to choose between them , the first choice is the first response (A) , the second choice is the second response (B) , the third choice (C) is to confirm that both first and second choices are valid and effective as a good response planning for its risk factor .

The total results of choice number C (Both A & B are valid) was about 95% for all 20 time risks & 20 cost risks which mean that the proposed risk responses for the top 40 risk factors were good and effective enough to be selected from those experts as a good solution .

Moreover , according to the questionnaire design the fourth choice was to add any proposed response planning from their experiences and professional background , the good achievement is that the original proposed responses in the questionnaire were 2 responses for every risk factor (40 * 2) equal 80 responses while the respondents replied with another 78 responses (36 for schedule risks & 42 for cost risks) which considered a very good added value to this survey as most of these risk responses were developed and actually used in real project life cycles according to meeting & calls with respondents as they had confirmed that their added responses were all actually implemented in many construction projects where they were involved in / under their supervision . Figure 5 A,B illustrates some responses charecteristics as below .

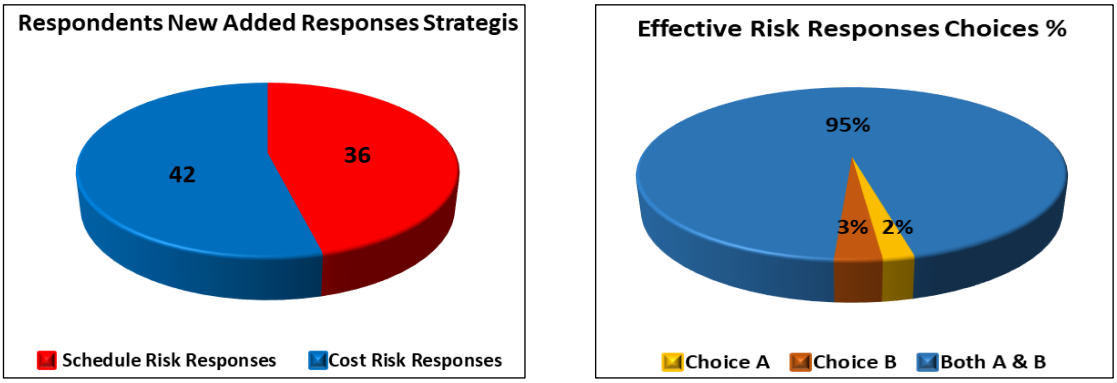


Figure 5 A,B: – Respondents Responses Characteristics

The main research includes all examples of the added proposed responses for both schedule & cost risks which identified and explained with the impact of using it in real projects in EGYPT , according to their valued feedback these responses positively affected the risk factors and actively succeeded in reducing the occurred deviations for both schedule & cost of their construction projects .

The added responses for schedule risks were as follow :

1 Owner financial instability
* Ensure that a reputable owner finances the project .
2 Repetitive payments delay
* Whenever possible to make all subcontracting contracts on back to back basis .
3 Insufficient financial / funding
* Ensure effective cost control system from the beginning of the project .
* Extending the original time schedule .
4 Late Material delivery
* Contracts with suppliers to define penalties.
* Define free issue items / tracking long lead materials .
5 Un-controlled change order
* Provision in contract to guide the change orders procedures and to preserve rights .
* Hiring a well reputed consultant to review drawings and calculations .
6 Bad commitment to schedule
* Provision in contract to apply penalties on missed milestones / contractual finish dates.
* Adopt fast tracking / crashing techniques .
7 Unrealistic fast track schedule
* No new added responses .
8 Lack of ability and experience
* Assigning a qualified subcontractors for a specific technical activities .
* Prepare training for all low experienced staff .
9 Poor resources planning
* Following up resources loaded into the time schedule to be delivered on time .
* Attending a weekly site meeting to discuss and monitor all resources availability .

10 Organization Weak procurement Cycle
* Hiring a well experienced procurement staff .
11 Poor major equipment management plan
* Organize site properly for maximum productivity.
* Check that equipment operator is qualified and bas a good advanced training to operate the equipment especially the automated brands .
12 Design changes during construction
* Accept and try to absorb any delay as much as possible. .
* Preparing a revised time schedule considering these impacts on the planned completion dates .
13 Labor unavailability
* Subcontracting to qualified contractors .
14 Low Equipment quality/productivity
* Making alternative planning with time and cost contingency .
* Assigning qualified maintenance team .
* Periodical lubrication, oil changes and filters changes, etc. must be implemented .
* Ensure the correct use of equipment according to its design .
15 Bad selection for subcontractors
* Minimize subcontracting as much as possible .
* Subcontract to technically & financially stable subcontractors only .
* Insurance against default of subcontractor .
* Ask subcontractors to submit their prequalification before bidding .
* Establish in-house departments specialized in complementary works .
16 Lack of decision making process
* Ensure having the qualified personnel in the correct field to take the correct decisions .
* Preparing a revised time schedule considering these impacts on the planned completion dates .
17 Poor Contractor pre-qualifications
* Assigning specific work packages to special contractors
18 Poor project control process
* Conducting special project control trainings & courses .
* Highlighting the weak point of the project control cycle to enhance it .
19 Unclear Project Scope Definition
* Record chronological records of all unclear issues to be inserted in any further extension of time claim .
20 Monetary Inflation
* Collect a periodic data about market inflation rate .

While the added responses for Cost risks were as follow :

1 Owner financial instability
* Making a severe cash flow study plan .
* Ensure that a reputable owner finances the project .
2 Repetitive payments delay
* Whenever possible to make all subcontracting contracts on back to back basis .
3 Insufficient financial / funding
* Ensure effective cost control system from the beginning of the project.
* Reduce scope / specifications .
4 Un-controlled change order
* Conduct value engineering studies / Outsourcing value engineering services
* Provision in contract to guide the change orders procedures and to preserve rights .
* Hiring a well reputed consultant to review drawings and calculations .
5 Monetary Inflation
* Collect a periodic data about market inflation rate .
6 Material damage / waste
* Very good mobilization plan including storage facilities and audits .
* Accurate quantities surveying for materials before issuing purchasing orders .
7 Design changes during construction
* Preparing a revised cost base line considering these impacts on the planned budget .
* Try to absorb minor changes as much as possible .
8 Poor resources planning
* Maintain a daily monitoring and following for all site resources activities .

* Organize site properly for maximum productivity .
* Tracking weekly progress reports to identify the weakness & to highlight critical issues .
9 Poor Quality / Rework
* Organize site properly for maximum productivity .
* Check that equipment operator is qualified and bas a good advanced training to operate the equipment especially the automated brands .
10 Poor major equipment management plan
* Assigning experienced team and out sourcing if necessary .
* Equipment must only work on its specific job according to equipment management plan .
11 Poor project control process
* Conducting special project control trainings & courses .
* Highlighting the weak point of the project control cycle to enhance it .
12 Bad commitment to schedule
* Provision in contract to apply penalties on missed milestones / targeted dates .
* Adopt fast tracking / crashing techniques according to CPI status .
13 Lack of ability and experience
* Assigning a qualified subcontractors for a specific technical activities .
* Prepare training for all low experienced staff .
14 Poor labor resource planning
* Evaluating the productivity rates for all labor trades of work & make on time re-planning .
* Assign responsibilities for each construction manager to evaluate results & targets .
* Tracking weekly progress reports to identify the weakness & to highlight critical plans.
15 Unclear Design specifications
* Hiring experts in estimating prices and study well the project and ask about all details .
* Making alternative planning with time and cost contingency .
* Trying to make the client involved in each step of missing design specifications .
16 Unclear scope definition
* Record chronological records of all unclear issues to be inserted in any further prolongation cost claim .
17 Low Equipment quality/productivity
* Making alternative planning with cost contingency .
* Assigning qualified maintenance team .
* Periodical lubrication, oil changes and filters changes, etc. must be implemented .
* Ensure the correct use of equipment according to its design .
18 Organization Weak procurement Cycle
* Hiring a well experienced procurement staff .
19 Bad Material storage
* Establish good inventory management system .
* Periodical auditing & visiting the storages by concerned management .
20 Skilled labor high wage scales
* No new responses added .

7. CONCLUSIONS

According to the above data and results of real response strategies implemented and applied on real construction projects , many examples were reviewed and investigated with the expert respondents which showed a strong positive impact on reducing the occurred delays due to schedule risks and on reducing cost overrun occurred due to cost risks .

Actually , the collected data is considered a real validation of risk response strategies for construction projects in EGYPT and reflects a strong experiences in dealing with most common risks affect construction projects negatively . A clear combined category of all the above data and examples shall be included in Appendix D .

8. RECOMMENDATIONS FOR FUTURE RESEARCHES

This research proposed a risk management methodology for construction industry in EGYPT , future researches may add in depth areas of research like :

1 - Risk monitoring and controlling process should take more attention , development and software creation in order to maintain more effective techniques that could help in that area of risk management .

2 – Create various expert systems using artificial intelligence to cover each process of risk management processes .

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