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Risk Assessment for Off-Shore Petroleum and Gas Construction Projects in Egypt

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Abstract The petroleum extraction and process industry including all its stages are considered a risky industry. As in the case of petroleum products and natural gas. Some studies indicated that petroleum would provide more than 90% of the energy needs of some countries, especially the densely populated ones like Egypt. Also, petroleum is considered a source of national income in various countries, including Egypt. Due to the importance of this industry, many companies are competing in this field, and the main competing factors are time, cost, and quality. In fact, contracting companies experience numerous problems during the implementation of such projects due to the poor assessment of the risks that might be experienced during the study and implementation phases of such projects. The research purpose is to identify and analyse the risks related to executing offshore petroleum and gas projects. This analysis is meant to assist contracting companies specialized in the petroleum & gas field in building confidence. Thru structured questionnaire, a field survey was established for the Egyptian corporations working in the offshore field. The structured questionnaire was to find out the probability and impact of the risk events listed in the questionnaire and to record any new element of risks that were not recorded in the questionnaire.
Quantitative risk analysis (QRA) tools were used to analyse the questionnaire data to exhibit statistical measures. Importance index (II) and average risk were calculated for offshore construction projects. In addition, risk factors ranking affecting the contractors alongside the factors between elements of risk factors have been discussed and developed. These factors have been used to identify the effect of risks on project cost and duration and were also used to compare the results with validation cases. The risk mitigation factors show the ideal cost and duration which the contractor should consider at the bidding phase to avoid cost increase and/or delays in project duration.

KEYWORDS**:** Construction risk management, Petroleum and Gas projects, Off-Shore Risk management, Risk assessment

1. INTRODUCTION

Petroleum and gas projects are described as extremely complex activities, where gaps arise from different sources. Petroleum and gas projects accumulate a major number of partners, which makes it hard to examine the overall system between those partners. However, these activities offer a perfect situation for system and risk investigation, past research and studies have considered the investigations of risk factors.

Abo Use if [1], studied the Egyptian power plant projects and located that the major risks related to those projects are as follows:
Inflation, incorrect specifications, exchange rate, currency availability, change order procedure, dispute resolution procedure, material cost.
Bakarman [3] studied the risks factors affecting the Egyptian contractors which are as follows:
Exchange rate devaluation, invoices delay by the owner, project financing difficulties by contractor, increasing cost due to miscalculation, inflation, subcontractor cash flow problems,

client delaying in contractor's claim settlement, construction project delay, work permits difficulty obtaining from the authorities.

Another research made by Chen-Ben et al. [4]suggested fifteen risks related to project cost and classified them into three categories, which are: parent, management and resources factors.

El-Shehabyet al. [5] studied the risk factors affecting the Egyptian petroleum & gas corporations working in off-shore projects and identified them as follows:

Waiting on weather, material price increase ratio, making decision delay by client, delay in contractor's submittals approval, performing inspection delay, the schedule is insufficient for the required activities.

Kumara-Swamy and Aeron [6] classified 41 risks in construction projects, thus, according to (Edwards) risk management is an important tool to cope with such substantial risks in construction industry as following:

minimizing losses by analyzing and controlling the risks, alleviating risks by proper planning, assessing and ascertaining project viability, avoiding dissatisfactory projects and thus enhancing profit margins.

Youssef [7] analyzed the risk factors affecting the construction corporations working in petroleum sector and summarized them as follows:

cost risks, schedule risks, contract risks, safety and occupational health risks, design and construction quality risks, process design risks, construction risks, procurement risks, environmental risks, operational risks.

Rao and Sreenivasan [8] studied factors affecting labor productivity in Bangalore by following Relative Importance Index (II). The conclusion indicates the ten main factors negatively affecting the productivity of labor are:

Lack of laborer experience, little amount of pay, working seven days per week without day off, specifications and drawings alteration during execution, poor relations between labor and supervisors, payment delay, rework, increase of labor age, weather down time condition, ignore safety precaution.

While Laryea [10] studied an experimental approach to project risk identification and prioritization in Ghana, the study shows that consultants face many risks such as " inefficiency, payment troubles, and excessive delays in the appointment of nominated subcontractors are significant risks, workers, entitlements, and inefficiency in the performance of consultants, Poor records keeping and sensitive nature of the data required, working drawings generally carry mistakes and insufficient specification details, Poor adherence to time schedules commitment.

Huynh and Bui [11] studied application of quantitative risk assessment on offshore oil industry the risks generated from normal operation of offshore facilities shall be adequately identified and controlled by a standard formal safety assessment, QRAiscarried out to assess the different parameters of risk exposed to facility personnel. Individual and societal risks are identified, quantified, and compared to acceptance criteria to ensure all risks exposed are identified and control within as low as reasonably practicable (ALARP) level. This is mitigated by leak and fire detection, isolation, blow down or control of ignition sources. Besides, the PFP should be provided to avoid the potential domino effects from ignited events.

Soleman [12] found that the highest risk factors affecting the Egyptian contractors working in on-shore petroleum & gas projects and identified them as bellow:

material price increasing, inflation loss, project financing (debt) (contract payment delayed), materials delaying, the schedule is insufficient for the required activities., the long period for bidding evaluation and purchase order cycle, the un-approvals of construction drawings, low equipment productivity, cost increasing due to miscalculation.

This paper finds out the reasons behind the gap between risk management techniques and their practical application by construction contractors. Additionally, this paper is based on the assumption by understanding both the relationships in a project network and risks related to the network structure, project risk management can be more effective. It is recognized that a clear knowledge of the risks born by each participant leads to better risk allocation and thus to a more accurate analysis of the results.

2. PROBLEM STATEMENT

Petroleum and gas projects are instances of overwhelming mechanical tasks. They are viewed as one of a kind as they need certified, particular and experienced labors that ought to have high mechanical and specialized abilities. They ought to have mindfulness, understanding and the capacity to survey a wide range of risks that they may face during the development of such tasks. A need exists for surveying the risks that face the workers thru the development of such projects. This research will handle the risks, their assessment and analysis for petroleum and gas offshore projects in Egypt from contractor point of view and experience.

3. RESEARCH OBJECTIVES

The research objectives were identified to be:

- studying the factors which may affect the construction activities of offshore petroleum and gas projects,
- analyzing and identifying potential risks,
- identifying the important risk factors affecting the Egyptian construction companies,
- investigating the important risk factors according to each company's point of view,
- Defining and assessing the most important factors of risks using a predefined questionnaire.

4. RESEARCH METHODOLOGY

The research is based on both types of data: primary data and secondary data.
The primary data had been collected through a questionnaire, while the secondary data had been collected from other researches, books, studies, and periodicals (conducted in the same **scope).**
The study was conducted through literature review to cover the most important studies in this research area. The survey conducted was based on this literature review to classify the most important risk factors affecting the Offshore construction projects in Egypt. Accordingly, data had been collected via a survey questionnaire among the corporations working in the field of offshore construction projects in Egypt, where analysis had been performed and results were analyzed by implementation on a validation case.

5. RESEARCH IMPLEMENTATION

This is a field survey study using a structured questionnaire that is closely related to offshore petroleum and gas construction projects. The survey identifies the probabilities of occurrence and degree of risk impact, that may confront these corporations during the construction of offshore projects, as well as ranks these risks in order of importance.
The research strategy summarized into

- performing a thorough literature review of the paper, interviewing and discussion with expert persons,
- formulating collected data to design and develop a comprehensive questionnaire covers the required data,
- conducting a field survey for Egyptian corporations working in offshore field,
- ranking the risk factors according to the responses of all companies working in this field in Egypt, in order of importance,
- demonstrating the impact caused by different risk elements on the performance of petroleum and gas projects through validation.

5.1QUESTIONNAIRE DEVELOPMENT AND DESIGN

This survey has been conducted in two stages. The first stage includes literature, data collection, field visit and interview. This leads to the creation of the questionnaire, which is distributed on construction managers at each company, according to the questionnaire sample which depends on the project manager at each surveyed company with 15 years' experience or more at the level of general manager assistant.
Question 1 comprises two parts, the first part (Part A) includes general questions relating to expert experience and are used for purpose of collecting data and information from the project managers.
While the second Part (Part B) includes a list of potential risks affecting the contractor during execution phase.
Question 2 spots data analysis and identification of the most relevant risk factors affecting the construction contractors working in Egyptian

petroleum field. As for the evaluation criteria, the companies' experience in the field are 10 years or more, the survey covers five companies working in this field in Egypt(Those fit the specifications), and show the numbers of experts representing every company.

5.2 FREQUENCY OF DURATION AND COST INCREASING.

The questionnaire survey results of frequency of increasing cost and duration in petroleum & gas construction projects are presented in Table 1 and Table 2 depending on the response of every company's experts.

The percentage in Table (1) shows the result of the questionnaire (Part A) for expert person's answers, this part shows how companies met the projects duration in previous projects.

While percentage in Table (2) shows the extent of commitment to the budget for the same previous projects of the companies.

TABLE 1 .Increasing of duration.

Duration increasing	Construction Offshore Companies Percentage				
	1st Company	2nd Company	3rd Company	4th Company	5th Company
Always	23.73%	38.57%	23.53%	10.53%	0.00%
Often	54.24%	32.86%	52.94%	26.32%	36.36%
Sometimes	18.64%	22.86%	23.53%	57.89%	63.64%
Never	3.39%	5.71%	0.00%	5.26%	0.00%

TABLE 2 . Increasing of cost.

Cost increasing	Construction Offshore Companies Percentage				
	1st Company	2nd Company	3rd Company	4th Company	5th Company
Always	15.25%	22.86%	5.88%	10.53%	0.00%
Often	6.78%	24.29%	11.76%	26.32%	27.27%
Sometimes	25.42%	37.14%	29.41%	57.89%	72.73%
Never	52.54%	15.71%	52.94%	5.26%	0.00%

5.3QUALITATIVE AND QUANTITATIVE RISK ANALYSIS

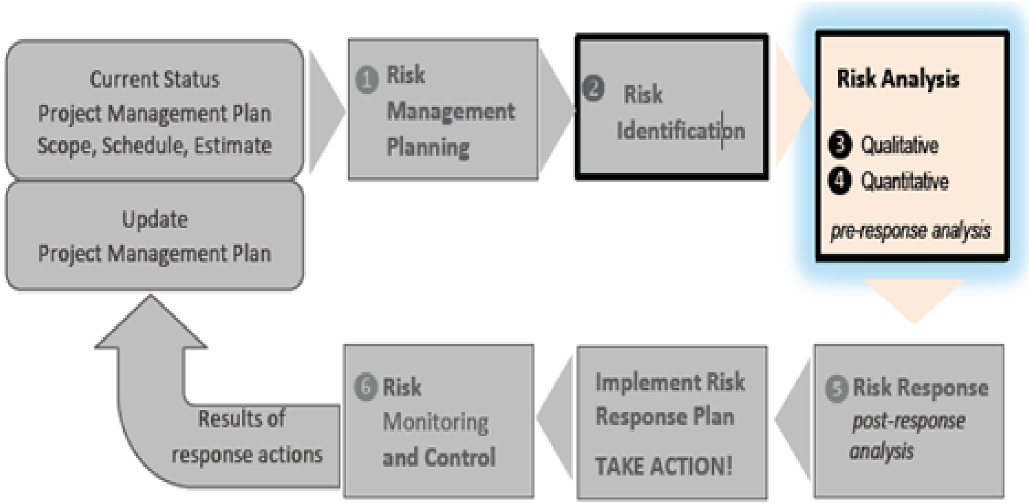

Fig 1. Risk Management Process.

The process of risk management includes four main steps: risk identification, analyzing risks, risk responses and monitoring as shown in figure (1).

There are two approaches to risk analysis – qualitative and quantitative.

Qualitative risk analysis (Q.R.A): is the process of assessing individual project risk characteristics - the probability of occurrence and the impact they would have on a project if happening - against a scale.
Q.R.A is a way of numerically estimating the probability that project will meet its duration and cost objectives. Quantitative analysis is based on simultaneous evaluation of the impacts of all identified and quantified risks.

Table 3 shows how probability scale was calculated by dividing it into 5 groups. First group is considered as very high probability pass down to 5th group which is considered as very low probability, each group was given a weight percentage that was determined to measure the probability of each item from the questionnaire

TABLE 3. The probability scale [9].

S	Probability scale	Description	Number (Ps)
1-	high	High likely	0.9
2-	Frequent	Likely	0.7
3-	Moderate	Possible and likely	0.5
4-	low	Possible but slightly unlikely	0.3
5-	Rare	Possible but very unlikely	0.1

Table 4 shows how impact scale was calculated by dividing it into 5 groups. 1st group is considered a very high impact pass down to 5th group which is considered as very low impact, each group was given a weight number that was determined to measure the impact scale of each item of the questionnaire.

TABLE 4. Impact scale [9].

S	Impact scale	Number (Ps.)
1-	Catastrophic	5
2-	high	4
3-	Medium	3
4-	low	2
5-	Unsignificant	1

This method was used (in this research) to rank the risk factors as shown below. for the ranking of risk factors, This method produced the same results, The method employed as follows:-

- Importance Index.

Importance index is used to assess the relative importance of risk factors before ranking them. It is determined by the probability index (P.I) and the impact index (I.I).

The following formula will be used to calculate the Probability Index (P.I) and Impact Index (I.I) of each factor. [2].

$$P.I = \left[\sum_{n=1}^{n} (PS * XP_S) / (P_{max})\right] * 100 \quad \text{Eq.(1)}$$

$$I.I = \left[\sum_{n=1}^{n} (IS * XL_S) / (I_{max})\right] * 100 \quad \text{Eq. (2)}$$

Where:-

PS / IS The probability of occurrence scales which expressing the constant weight assigned to option (s).

XP_S Variable expressing number of responded who selected option (s) for probability of occurrence.

XL_S Variable expressing number of responded who selected option (s) for degree of impact.

P_{MAX} The maximum probability of occurrence scales.

I_{max} The Maximum impact of occurrence scales.

n Total respondents 'number.

Then calculated the Importance Index (IMP. IND.) by using the below formula:

IMP. IND.% = (P.I * I.I.) * 100 Eq. (3)

A number of 176 qualified persons responded to the questionnaire, Table 5 shows the summation of all applicants' answers in each group, implementation of calculation is given in Eq.1, Eq.2 and Eq.3

TABLE 5. Degree of Impact and Probability of Occurrence Respondents.

Probability of Occurrence	(XPs)	Degree of Impact	(XIs)
High	20	Catastrophic	17
Frequent	26	High	43
Moderate	53	Medium	49
Low	54	Low	42
Rare	23	Un significant	25

Total respondents (n) =176

PI=[(20*0.9+26*0.7+53*0.5+54*0.3+23*0.1)/(176*0.9)]*100
= 51.26%

II= [(17*5+43*4+49*3+42*2+25*1) / (176*5)]*100 = 58.29%
IMP.IND.%= (PI * II) * 100
= (51.26% * 58.29%) = 29.88%

The given results are a special case for this questionnaire only, these equations can be used for other projects and different results will be obtained, the difference of results is based on the elements registered for the projects and the degree of impact and probability.

6. SURVEY ANALYSIS

The questionnaire provided a set of risk factors for respondents, which they were to assign probability of occurrence and degree of impact. The sections bellow discusses and present concerning results for the probability of occurrence and degree of impact

The probability of occurrence and degree of impact of the risk factors were measured by the scores assigned to each factor by the statistical techniques used by the respondents to analyze and interpret the collected data on the probability and impact scores of the risk factors. Each of the aforementioned scales has five levels ranging from 0.1 to 0.9 and 1 to 5. Calculation is one of the techniques, standard deviation standard error and confidence intervals.

The risk score identifies the most significant risk factor in this study. In our study the risk score ranges from 0.1 to 4.5, and this limitation is divided into four levels, as shown below.: [9].

- Negligible from 0.1 to 0.6
- Low from 0.6 to 1.5
- High from 1.5 to 2.8
- Extreme from 2.8 to 4.5 is.

- Extreme from 2.8 to 4.5 is.

		Impact				
		Unsignificant	Low	Medium	High	Catastrophic
Probability	Rare	Medium	High	Extreme	Extreme	Extreme
	Low	Medium	High	High	Extreme	Extreme
	Moderate	Low	Medium	High	High	Extreme
	Frequent	Low	Medium	Medium	High	High
	High	Low	Low	Low	Medium	Medium

Fige 2. Risk Matrix.

In this case, the calculated value exceeds the critical value, so the null hypothesis is rejected, and it is concluded that all corporations agreed on the importance ranking of the risk factors. Table (6) shows the major risk factors affecting the offshore construction project

TABLE 6 .Important risk factors affecting the construction.

serial	Risk Factor	All Companies	
		Des.	Score
1	Bad weather effects on project	High	2.73
2	Material price increasing ratio	High	2.15
3	Currency fluctuation	High	1.62
4	Complex design criteria	High	1.83
5	High quality control standard	High	2.06
6	Delay in the evaluation of bidding offers and the purchase cycle	High	1.65
7	Delay of engineering designs during work	High	1.52
8	Design errors	High	1.68
9	The schedule is insufficient for the required activities	High	1.80
10	Owner delay in contractor's submittals acceptance or approval decision.	High	2.16
11	consultant Delay in inspection, testing and approvals	High	1.9
12	Conflict between consultant and contractor	High	2.08
13	The schedule commitment (delay due to contactor)	High	1.78
14	Pay liquidate damage	High	1.63
15	Utilizing the company resources / Lack of good coordination of the company's resources in the service of different projects	High	2.47
16	Increase in labor price	Low	1.23
17	Delay of mobilization	Low	1.46
18	Shortages of qualified labors	Low	1.4

By analyzing the aforementioned activities and their significance, it was discovered that there are some activities with a very high probability of occurrence and impact, such as:

- Bad weather effects on the project: by study this activity we discovered that the probability of this item is greater than 75%, as well as its impact on project cost and duration ,This effect can take the form of a delay in transporting materials to the project site or a halt in project activities. This means that this item could add more than 40% of the total execution time to the schedule, also, it has an impact on the project's cost, which is wasting operation productivity time.
- Material price increasing ratio: due to market inflation which effect directly on project cost the project team should consider and controlling the material price during the project study.
- The above activities mentioned in table 6 are considered high probability and high impact, all companies shared in the civil survey agreed on this point. These activities

are used in the modelling below. The activities were matched and are proved to have a direct effect on the project duration and cost.

A comparison between these results and previous results is shown in Table (7).

TABLE 7. Comparison between these results and previous results.

N	This research			El-Shehaby Research 2014 [5]			Soleman Research 2009 [12]		
	Risk Factor	Des.	score	Risk Factor	Des.	score	Risk Factor	Des.	score
1	weather affection	High	2.73	Bad weather effects	Extreme	2.80	-	-	-
2	Material price increasing	High	2.15	Material price increasing	High	2.2	Material price increasing	Extreme	4.1
3	Currency fluctuation.	High	1.62	Currency fluctuation	High	1.6	Loss due to inflation	Extreme	4
4	High design criteria	High	1.83	-	-	-	-	-	-
5	High quality control standard	High	2.06	-	-	-	-	-	-
6	Delay in the evaluation of bidding offers and the purchase cycle	High	1.65	Delay in the evaluation of bidding offers and the purchase cycle	High	1.70	Delay in the evaluation of bidding offers and the purchase cycle	High	2

N	This research			El-Shehaby Research 2014 [5]			Soleman Research 2009 [12]		
	Risk Factor	Des.	score	Risk Factor	Des.	score	Risk Factor	Des.	score
7	Delay of engineering designs during work	High	1.52	-	-	-	-	-	-
8	Design errors	High	1.68	-	-	-	-	-	-
9	Project schedule duration is too short	High	1.80	Project schedule duration is too short	Hig h	1.70	Project schedule duration is too short.	High	2.1
10	Owner delay in contractor's submittals acceptance or approval decision.	High	2.16	Owner delay in contractor's submittals acceptance or approval decision.	Hig h	2	-	-	-
11	Consultant delay in inspection, testing and approvals	High	1.90	Consultant delay in inspection, testing and approvals	Hig h	1.9	-	-	-
12	Conflict between consultant and contractor	High	2.08	Conflict between consultant and contractor	Hig h	2.1	-	-	-
13	The schedule commitment (delay due to contactor)	High	1.78	The schedule commitment (delay due to contactor)	Hig h	1.7	Vendor Bid Greater Than Estimate	High	1.9
14	Pay liquidate damage	High	1.63	-	-	-	Shortage of Approved ForConstru ction Drawings	High	1.9

1.

N	This research			El-Shehaby Research 2014 [5]			Soleman Research 2009 [12]		
	Risk Factor	Des.	score	Risk Factor	Des.	score	Risk Factor	Des.	score
15	Utilizing the company resources / Lack of good coordination of the company's resources in the service of different projects	High	2.47	-	-	-	Low Productivity of Equipment's	High	1.9
16	Increase in labor price	Low	1.23	-	-	-	Cost overrun due to planning estimation	High	1.7
17	Delay of mobilization	Low	1.46	-	-	-	Project Financing (Debt,) (delayed payment on contract)	High	1.7
18	Shortages of qualified labors	Low	1.4	-	-	-	Delay in materials delivery	High	1.6
*	IMP .IND.%		29.88 %	IMP .IND.%	26.97%		IMP .IND.%		18.32 %

7. VALIDATION

The selected offshore project is a major offshore project for Egyptian oil Company, which is located at Gabil-Al Zaiet, Red Sea, Egypt.

The purpose of this project is to boost the production of Ras Ghareb offshore field located in the Gulf of Suez, by installing 2 new platforms: “A" and “B” in about 24 m water depth along with a new 6“subsea pipeline. The new 6" subsea pipeline is about 8 Km long and transport the fluid from the A P/F to C existing platform and connected with B P/F through Barred Tee, the New P/L located in 25 m water depth so that the new production would be transported to North onshore Planet via the existing 8" subsea pipeline, there are a topside modification will be required on C existing platforms.

The project overall duration is 23.5 months. The expected/intended offshore installation works to take place in two campaigns:

(1) 1st campaign (53 D) starting from 15 Nov. 2016 to 7 Jan. 2017
(2) 2nd campaign (70 D) starting from 19 Jan 2017 to 31 Mar 2017

Based on project schedule plan, the project original duration was planned to be 136 Days, starting from 15 Nov. 2016 till 31 Mar. 2017. The actual project duration was reported as 56 % of delaying than the original duration, it completed on 21 September 2017 with total delay of 175 days. The reason behind these extensive delays is shown in Table 6.

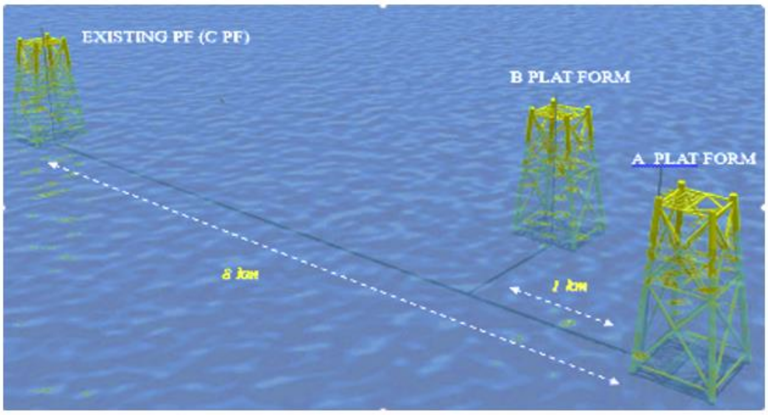

Fig 3. Project layout.

Figure 4 shows the comparison between planned duration and actual duration in project, the chart shows that the duration of the project has been increased by 56 %. With a total duration of 310 day's instead of 136.67 day's planned.

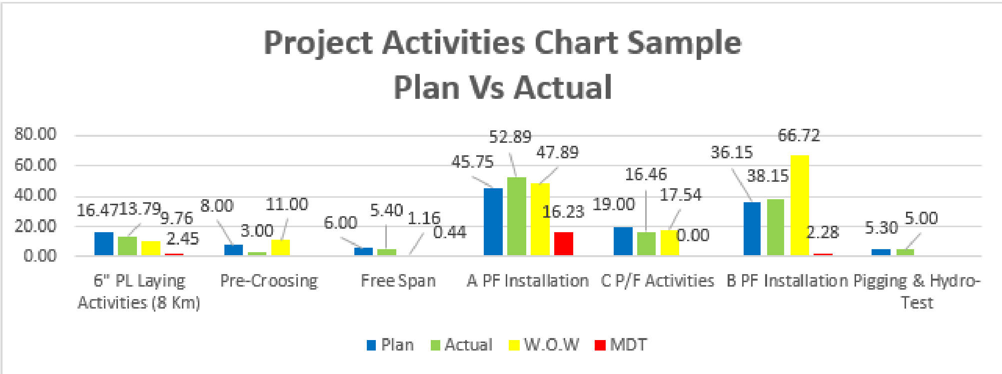

Fig 4. Planned Duration Versus Actual Duration

By applying the risk factor shown in Table 6 into this validation case, we find that the risk factors have been applied as shown in Table 8.

TABLE 8. Comparison the results of the correlation.

N	Risk Facto	A PF	B PF
1	Bad weather effects	√	√
2	Material price increasing	√	√
3	Currency fluctuation	√	√
4	High design/designer criteria	-	-
5	High quality control standard	√	√
6	Delay in the evaluation of bidding offers and the purchase cycle	-	-
7	Delay of engineering designs during work	-	-
8	Design errors	-	-
9	The schedule is insufficient for the required activities	√	√

10	Owner delay in contractor's submittals acceptance or approval decision.	-	√
11	Consultant delay in inspection, testing and approvals	√	-
12	Consultant and contractor conflict	√	√
13	Schedule commitment (delay due to contactor)	√	√
14	Pay liquidate damage	√	√
15	Utilizing the company resources / Lack of good coordination of the company's resources in the service of different projects	√	√
16	Increase in labor price	-	-
17	Delay of mobilization	√	√
18	Shortages of qualified labors	-	-

By applying the study above to the validation case, the following had been concluded:

- Scheduled plan (Days): 136 days
- Actual Delay (Days): 175 days.
- The marine unit dry Cost/day: 65,000 USD
- Cost Impact = 175 days * 65,000 dry cost = 10,500,000 USD (-ve)
- If the contractor has previously studied the risk factors for the project and calculates the Expected Monetary Value (EMV) his reserve will be as follow:
- EMV = 21,875,000 * 0.2988 (contingence factor) = 6,536,250 USD

The EMV will decrease the –ve cost of the contractor = 10,500,000 – 6,536,250 = 3,963,750 USD even if he considers the risk factor on his proposal it can help him to avoid the –ve cost.

Also we implement the past studies EMV which shown in table 7, we found the below

- EMV = 21,875,000 * 0.2697 (contingency factor) = 5,899,987.5 USD [El-Shehaby] [5]

The EMV will decrease the –ve cost of the contractor = 10,500,000 – 5,899,987.5 = 4,600,012.5 USD

- EMV = 21,875,000 * 0.1832 (contingence factor) = 4,007,500 USD [Soleman] [12]

The EMV will decrease the –ve cost of the contractor = 10,500,000 – 4,007,500 = 6,492,500 USD

8.DISCUSSION

Much previous research has dealt with many risks that affect projects, since off-shore projects are among the modern fields in Egypt, the goal was to identify the risk factors that affect this type of marine projects, in order to reach the maximum possible benefit from taking advantage of positive risks and avoiding negative risks, it is known that the risk factors change according to the environmental, social and economic conditions of the countries in which this activity is created. Therefore, presenting many future studies and identifying new risk elements is required for this area, studying risks that affect projects is a kind of study unknown items and with the passage of time, this unknown becomes known, and appears new future unknown elements and so on.

9.SUMMARY AND CONCLUSIONS

The following findings and summary are drawn:

- Two corporations out of five taking part in this study have been practicing the off-shore petroleum projects for 40 years, while the other two corporations have been practicing the off-shore petroleum projects for 20 years, the remaining corporation have been practicing for 18 years.

- Four corporations out of five in this study agree on a degree of delay in their projects arising caused by not facing risk factors.
- Four corporations out of five in this study agree on degree of cost over run in their projects resulting from arising caused by not facing risk factors.
- All of the corporations that took part in this study agreed on the importance of these risk factors. According to the analysis, the majority of the top five risk factors affecting corporations working on off-shore petroleum and gas projects in Egypt were:

- The weather effect on the project.
- Utilizing the company resources / Lack of good coordination of the company's resources in the service of different projects.
- Increase in material price.
- Owner delay in contractor's submittals acceptance or approval decision.
- High quality control standard.

The conclusion of this research is an EMV calculation that can be used in petroleum and gas projects in Egypt. What has been achieved through an EMV mechanism through this research can be used in petroleum projects in Egypt, it improves the optimal use of risks and gives positive responses that improve project management with a high degree of accuracy, Itis recommended to update EMV on an ongoing basis by recording future risks in the project industry.

Determining the elements of risk in projects needs more future studies, due to the continuous change in risk elements according to future changes, where some of the risk elements that currently affect projects may fade with future projects with the emergence of new risk elements that were not currently discovered, and therefore, updating risk factors and risk register list components every two years is very important to reach a suitable EMV

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