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Risk Identification and Assessment of Mega Industrial Projects in Egypt

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Abstract: **Owners tend to use (custom) contracts to suit their project needs and specifications, and they often assign excessive risks to contractors. The current paper's goal is to look into the current risk distribution in Mega industrial projects in Egypt. Where correctly identifying, assessing, and allocating risks in contracts can improve project performance. Based on an extensive literature review, the study identified 70 risk factors that are divided into nine groups. The respondents were asked to estimate the probability, impact, and way to control these risk factors. The results indicate that there is a problem in allocating risks in these projects and the top-ranked risk factors are procurement Problems, subcontractors' failure to comply with the schedule, unclear responsibility matrix, indecisive management, compliance risks (H&SE), and delay due to permit and consent from statutory bodies. These risk factors demonstrated that the current risk allocation practice in construction projects is inefficient and led to several other problems, such as claims, disputes, and aggressive relationships. The research is divided into two papers, Paper II will discuss how to mitigate these problems by redistributing risks equitably in a balanced construction contract to eliminate conflicts and adversarial relationships. The study's findings may help practitioners in allocating risks to partners who are better able to assess, control, and manage them. The risk ranking that was produced can be used to evaluate risks for contingency planning.**

Keywords: **Risk allocation, Relative Importance Index, Frequency-Adjusted Frequency Index, Risk identification, optimal risk, risk management.**

1. INTRODUCTION

The urgent demands for the Implementation of Mega industrial projects in developing countries like Egypt increase challenges and difficulties for project management units. These demands made the urgent need to shed light on current risk allocation procedures in these projects. Furthermore, the complex nature of Mega Industrial projects is increasing, leading to increase in the severity and frequency of risks that are common in these projects**, (Youssef, A, et al, 2018.).** Because of these complexities, unambiguous definitions of contracting parties' rights and obligations are necessary. As risk is a permanent feature of the industrial project, so good management of the same, could contribute to an increase in profit and competitive advantages. Several experts conducted risk assessment studies in the construction industry in diverse parts of the world, including the United States, Europe, and East Asia. However, in the Middle East construction industry, such research is limited, **(Eskander, et al, 2018.).** Shifting the unmitigated risks to one party of the construction project is unfair and unreasonable, however, more often there is little parity in risk allocation in the construction projects. Where inappropriate risk allocation has led to adversarial relationships between contracting participants and contributed to increasing disputes and claims. Even though numerous important studies on construction risk in industrial projects have been conducted, there are still several research gaps yet to be filled, **(Hanna, et al 2013).** Each of the studies available provides a piece of the solution, but the construction industry still needs a universally acknowledged full, multiparty, no unilateral risk allocation sustainable model. In support of a collaborative relationship between holder and contractor spreads widely among researchers and practitioners, where numerous research efforts have been undertaken over the last decades regarding the allocation of construction risks, **(Zhang, L., et al, 2017).** Although the currently available researches offer a lot of useful insights into the problem, industry participants remain concerned about the risk associated with mega projects. Contract relationships in Egypt's industrial projects have become increasingly strained in recent years, as several working relationships, communications, and contractual duties are not being carried out in good faith and in a transparent manner. **(Marzouk, M., 2011).** The advocacy of a collaborative relationship between holder and contractor spreads widely among researchers and practitioners**, (Zhang, S., et al, 2016).** According to their study, **(Assaad et al. 2020b),** some risks can be managed in a proper way be not assigning to them to a single party and such risks must be shared by both contracting parties. In this case, different construction risk provisions are frequently found in the general conditions of a contract between project parties. (Even with a better awareness of the risks associated with industrial projects and a good risk allocation approach, **(Hanna, et al (2013)** determined that the projects will always be risky. However, by properly writing construction contract clauses, risk can be effectively allocated, removing many of the ambiguous and illegal arguments. However, to reduce risks during project implementation, contract requirements are getting stricter, with a growing number of new contract types. This paper presents the critical risk factors for design-build projects in the construction industry. Good identification and management of these risk factors will help projects succeed and will increase the confidence of owners and contractors who seek to use the ad hoc contract based on the design-build contract form.

2. LITERATURE REVIEW

Booming in the industrial projects in Egypt in the last years, made an urgent need to shed light on current risk allocation procedures and study the obstacles to optimum risk allocation. The Mega Industrial projects are subjected to a large number of risks that have a great effect on the outcomes of Megaprojects. In addition, it has been noted that Megaprojects are more subject to risk than in many other industries because of the complexities, uniqueness, dynamic nature, long project duration, and the aggressive environment, **(McCord, M., (2015)**. Furthermore, the complex nature of Mega Industrial projects is increasing, leading to increase in the severity and frequency of risks that are common in these projects, **(Youssef, A, et al, 2018.).**

For several years' great effort has been devoted to the study of equitable risk allocation between the project parties (owner, designer, contractor; etc.). **(Nasirzadeh, F., 2014),** indicated that risk allocation has thus been a hot topic of research in recent years, as a key issue of contractual governance for construction projects. Because of the increasing complexities and dynamics of the risks involved in Mega-projects and mission management approaches for these projects, **(Boateng, P., 2015),** indicated that successful planning strategies among project team members continue to use risk quantification and modeling as a means to promote an effective risk response. Contract relationships in industrial projects have been increasingly strained in recent years. communications, and contractual duties not being performed in good faith. Whereas **(Li, Y., et al., 2017**) stated that an imbalanced risk allocation between contractual parties is a critical decision that raises the total cost of a project and has an impact on the overall relationship between contracting parties. Where it is unfair and unreasonable to pass the risk onto one of the parties to a construction contract agreement, **(Peckiene, A., 2013)** determined that an equitable allocation of risks between parties is critical. The unbalanced allocation of risks between contracting parties is an important decision that leads to an increase in the total cost of a particular project and affects the overall relationship between them, Consequently, **(Khazaeni, G., et al, 2012)** showed that due allocation should be determined by the balance of interests of the parties. Risks can hardly ever be removed in construction projects; they can only be shifted to another party to a construction contract arrangement or shared under specific contractual conditions. Consequently, **(Peckiene, A., 2013)** it is suggested that there is a fifth stage in addition to the four key stages of the risk management process – risk allocation between the contracting parties. The construction research community is no novice to the problems of risk allocation and management. Risk allocation and sharing in contracts have been studied by researchers in several sectors of the construction industry, and have been investigated in specific contract forms**, (Youssef, A., et al, 2018.).**

There is commonly little parity in risk allocation in construction projects, however, project owners often allocate more risks to contractors when designing contracts by using the pre-contract bargaining power, **(Nasirzadeh, F., et al, 2016).** Furthermore, there is no consensus among construction project participants on the optimal risk allocation strategy. Some scholars suggest that such an unbalanced allocation of risks will lead to defensive strategies on the part of the contractor by reducing the quality of work or by claiming overcharges, **(Groton, J., and Smith, R. J. 2010).**

In the last few years, there has been a growing interest in risk management. Risk management plays a vital role in the construction industry, **(El-sayegh, S. M. (2008)**. In truth, risk management is essential since it improves a business' profitability, and failing to do so might have negative consequences, **(Assaad, R., and I. H. El-adaway. 2020c).** In practice, project risk management is a process that involves identifying sources of risks and uncertainties (risk identification), estimating the likelihood and effects of uncertainties (risk analysis), developing strategies to react to the risks examined (risk response), and finally tracking such risks and repeating such steps across the project's life cycle **(Zavadskas, E. K., et al, 2010).**

2.1 Problems with current practice of risk allocation

Many construction projects fail to achieve all of their intended objectives. In terms of extreme project delays, cost overruns, and poor efficiency, such a failure may be understood. The presence of risks and uncertainties inherent in the development and execution of projects plays a major role in such a failure **(PMI. (2017).** The negative impacts of defined risks can be reduced by using a five-phase risk management approach including risk management strategy, identifying risks, performing qualitative risk analysis, performing quantitative risk analysis, and planning risk responses **(Nasirzadeh, F., 2016.).** According to the reviewed literature, this part examines and evaluates the previous researches to highlight problems with existing risk allocation practices in the construction sector. Poor risk management and sub-optimal risk allocation appear to be linked to disputes, tension, delays, and cost overruns in construction projects.

A. Disputes

In the Egyptian industrial project, disputes have become a routine phenomenon. If not managed efficiently, such a phenomenon would hinder the success of these projects in Egypt and thus slow the development wheel. Since the fact, that all Mega industrial projects are full of risks and uncertainties is one of the main reasons for not achieving the project objectives. The failure of the project parties to comprehend their contractual obligations is one of the most common causes of disputes and claims in the construction industry, **(Khalef, R., et al, 2021)**. The construction industry is typically vital for any country's economy. Construction disputes cost an average of $33.0 million and take an average of 17 months to resolve, **(ARCADIS, 2019).** In 2016, claims and disputes were common in most industry sectors, but they were widely prevalent in public sector and social infrastructure projects. According to the **ARCADIS 2017** study, the number of claims and disputes on oil and gas projects is increasing as the industry becomes more cautious in response to low oil prices. In recent years, contract relationships in construction projects in Egypt have become even more complicated. Working partnerships, correspondence, and contractual agreements are still not conducted in good faith. In general, disputes arise due to the conflicting priorities of many project stakeholders. These conflicts cause additional resources which are utilized unproductively and consumed unnecessarily, **(Illankoon, et al, 2019).** Over the last 20 years, the Cairo Regional Center for International and Commercial Arbitration reported more than 220 lawsuits submitted for arbitration. A survey questionnaire was conceived by **(Marzouk, M., 2011)** to get the reasons for the disputes, highlighting forty-four causes of construction disputes. The most common causes of disputes will direct project parties (owners, contractors, and consultants) in addressing these causes. **(Gandhi, M. et al, 2017)**, revealed that factors like Scope changes, improper contract documentation, limited access, unforeseen site conditions, and contractual ambiguities, are contributors to disputes. In their study to reduce the overall costly claims and disputes**, Hiyassat, M.A., et al, 2020**, identify 62 risk factors that are grouped under 14 categories. The top-ranked risk factors were delays in client payments, improper contract forms, competitiveness, delays in permit approval, subcontractor default, poor specifications, material price changes, different construction standards, design change, and poor implementation.

According to the International Monetary Fund, the baseline global growth forecast for 2016 was a modest 3.2 percent which is largely in line with 2015, but a downward change of 0.2 percent from January 2016. Recovery was projected to reinforce in 2017 and beyond, driven primarily by developing economies as conditions gradually normalize in those stressed markets. However, there are major risks in the forecasts and some turbulence in the markets is expected which, in turn, could affect the level of construction disputes **(Global Construction Disputes Report 2016.)**. According to this report, the most common cause of disputes – poor contract administration is illustrated in TABLE 1. The report showed that a new cause in the rankings is related to incomplete design information, which is generally considered to be associated with poor design information quality, and a global proportionate increase in the use of design and contract forms. In some industries, the introduction of EPC contract forms has been especially problematic.

TABLE 1: The Most Common Causes of disputes

2015 Rank	CAUSE	2014 Rank
1	Failure to properly administer the contract	1
2	Poorly drafted or incomplete and unsubstantiated claims	2
3	Errors and/or omissions in the contract document	3
4	Incomplete design information or employer requirements (for Design and Build)	New
5	Employer/contractor/subcontractor failing to understand and/or comply with its contractual obligations	4

B. Time and cost overruns

Underestimated risks often lead to financial losses, **(Peckiene, A., 2013)** shows that the results of defensive risk strategies include overruns in time and cost and poor quality. Therefore, to achieve good project performance defensive strategies toward risk it is necessary to allocate risks equitably **(Nasirzadeh, F., 2016).** Delays and cost overruns are common problems in several developed and developing nations within the construction industry. **(Abdullah, et al,2018)** During identification of factors that cause delays and cost overruns when constructing refinery projects for palm oil, they found that delays in subcontractor work, lack of subcontractor ability, and poor/insufficient planning and scheduling are the most significant causes of delay. According to **(Pham, L.H. et al, 2014)** research, some of the delays are related to the contractors, project owners, authorities, and external sources, (i.e. weather). As a result, to improve the project duration, the contractors must strengthen their project management skills. Furthermore, the project owner must carefully choose the contractors based on their technical and management abilities. In the fundamental design (or front-end-engineering design (FEED)), the project owner must also set clear project scope, maintain the project requirements, and avoid design changes. Based on existing research literature on Causes of Client Cost Overruns and time delays in construction projects, (**Adam, A., et al, 2015)** concluded that the causes determining cost overruns and time delays often intersect. As a result, two projects with the same fundamental cause for a cost overrun or schedule delay could have completely different interpretations. Each explanation is unique and path-dependent on the project under investigation, and thus cannot be directly transferred to another project.

C. Claims

As the number of lawsuits relating to construction projects has increased, construction contracts play a critical role in preventing these kinds of legal and administrative risks which can lead to claims. **(Mohammadi, S., 2016)** present the study aims to raise awareness of such likely risks among construction professionals by not only identifying legal risk factors that may lead to claims in sustainable construction but also assessing the criticality of each risk factor by seeking the opinion of industry professionals and analyzing these factors using the relative importance index method. Changes in owner requirements, extra labor, delays/acceleration, varying site conditions, and contract ambiguity were all common causes of claims **(Komurlu, R. et al, 2017)**. While (**Dastyar, B., et al, 2018)** provided that contractors' financial problems, lack of materials, and their elevated pricing, offering contractual price less than required tender price were the most important factors which affect claims. Risk management in construction projects is still very ineffective, **(Haidar, A., 2011)** presented a brief description of this problem in their research. According to their research, unbalanced bidding and underestimation are well-known reasons for claims. Several authors have studied the reasons for claims, **(Mohammadi, S. and Birgonul, M.T., 2016)** stated that unreasonable contract clauses, and also a lack of clarification in contract documents in terms of a performance period, payment, and changes, contribute to contract-related disputes. Consequently, any new risks and unforeseen events may arise as the project progresses, resulting in potential disputes and a breakdown of the relationship. **(Vickery, H., 2004)** discusses the primary factors in the design of construction contracts to close loopholes giving rise to claims by contractors, the use of performance bonds to transfer the risk of cost overruns and delays, dispute settlement procedures to reduce litigation, and the negotiation strategies to plan for litigation should the worst happen. According to their observations **(Andersson, C., et al, 2002)**, indicate that disputes also include extensions of time, scope changes, payment, administration, contractual obligations, and so on. One of the reasons for disputes, according to them, is that the affected party failed to recognize the risk as relevant to the project.

Consequently, any new risks and unforeseen events may arise as the project progresses, resulting in potential disputes and a breakdown of the relationship. The International Association for Contract and Commercial Management (IACCM 2011), in its 10th Annual Survey, Top Terms in Negotiation discussed the most frequent sources of claims and disputes. The main findings are summarized in TABLE 2. The owner prefers, in general, to assign more risks to the contractor and accept as little risk as possible. In this case, the contractor may increase the project tender price based solely on the fact that he is solely responsible for the circumstances that may arise during the project, **(Peckiene, A., 2013).**

TABLE 2: Most sources of claims and disputes

Issue	% reported	Issue	% reported
Delivery/acceptance	41	Price/charge/price changes	38
Change management	32	Invoices/late payment	30
Performance/guarantees/undertakings	27	Service levels and warranties	27
Payment	25	Responsibilities of the parties	22
Liquidated damages	22	Scope and goals	21
Warranty	16	Limitation of liability	16
Indemnification	14	Service withdrawal or termination	14
Intellectual property	12	Audits/benchmarking	10
Assignment/transfer	8	Dispute resolution	8
Data protection/security	7	Communications and reporting	7

3. PROBLEM STATEMENT

It is unfair and unreasonable to pass the risk onto one of the parties to a construction contract agreement, simply because the risks will remain latent in the project and will eventually affect all participants. A review of the literature shows that there is a lack of distribution of risks between contractors and owners in major industrial projects in Egypt. Based on this, the goal of this paper is to investigate risk factors in industrial projects in Egypt, as well as to identify, assess, and formulate a classification of the problems and obstacles to optimum risk allocation in industrial projects. Then, this article will address the significant risk factors for design-build projects in the construction industry. Good managing of these risk factors will help owners and contractors who seek to use the design-build contract in project success. The research will aid in not only identifying and evaluating risk factors in Mega industrial projects but also in allocating these risk factors among contractual parties via contract terms, as well as contributing to a better understanding of risk control strategies from the owners' and contractor’s perspectives. This research examines the major risk factors for design-build projects in the industrial sector.

3.1 Research Objectives

The main objective of this research is to identify and study the significant risk factors in mega industrial projects in Egypt. Then, developing a balanced construction contract that helps to reallocate these risks in which to improve the relationship between the different parties to the project. This will be done by identifying the risk factors that affect the project life cycle, researching the contract clauses related to each risk, and amending these clauses, or adding other clauses that can mitigate or eliminate these risk factors.

4. RESEARCH METHODOLOGY

The research methodology describes the research activities; what the work was done and how it was performed and is logically related to the objectives of this research. The research methodology includes a prior literature review of available work published on risk identification and sources of risk in Megaprojects. The available published literature was reviewed and analyzed, therefore a structured survey questionnaire was developed and distributed. To rank these factors in terms of their probability and effects, a statistical analysis of all collected data was performed using (Statistical Package for the Social Sciences) SPSS Ver.23 software. Pearson correlation coefficient and Cronbach alpha coefficient were carried out to determine the validity of internal and structural research, and the reliability of the questionnaire between each field and the average of the entire questionnaire fields respectively. The characteristics of risk allocation in construction projects were graded and ranked using The Relative Importance Index (RII), and Adjusted Frequency Index (FAII) that can determine the importance of the attributes of the risk allocation. The following is a summary of the methodology:

1. In order to investigate the problems of the current practice of risk allocation in the construction industry, an extensive literature review of similar researches was reviewed

2. To help the investigation, a structured questionnaire was developed and distributed to construction practitioners, and including all risk factors affecting predetermined criteria for the construction projects in Egypt.

3. Respondents were then asked to prioritize these risk factors regarding their probability and consequences on predetermined criteria for the construction projects.

4. Statistical analysis for all collected data will be carried out using SPSS Ver.23 software (Statistical Package for the Social Sciences to rank the risk factors.

5. The provisions of the FIDIC Yellow Book contract were examined, in regards of the conclusion to the questionnaire analysis,

6. An inductive approach has been made to consider the terms of the FIDIC Yellow Book contract in Egypt, the changes being made to make it a balanced contract, and the results of these changes.

Developing a simple balanced contract that can be used in the construction project in Egypt.

4.1 Questionnaire Design

The questionnaire consists of two sections; the first section includes general details about experts representing their companies in construction fields. While the second section addresses the main questions regarding identifying the risk factors, respondents were then asked to prioritize these risk factors regarding their probability and consequences.

4.2 Sample Selection

The following Equations was used to obtain the representative sample:

$$SS = \frac{Z^2 * (P) * (1-P)}{e^2} \qquad \text{Equation 1.}$$

SS: $(calculated\ sample\ size)$

Z: value for the confidence level (e.g. 1.64 for 95% confidence level)

p = percentage picking a choice, expressed as decimal

(0.2 used for sample size needed)

e = confidence interval, expressed as decimal

(e.g., o.08 = ±8%)

$$SS\ (sample\ size) = \frac{1.64^2 * (0.2) * (1-0.2)}{0.08^2} = 68 \qquad \text{Equation 2.}$$

Another correction equation with a known population is:

$$SS_{corr} = \frac{SS}{1+\frac{SS-1}{pop}} \qquad \text{Equation 3.}$$

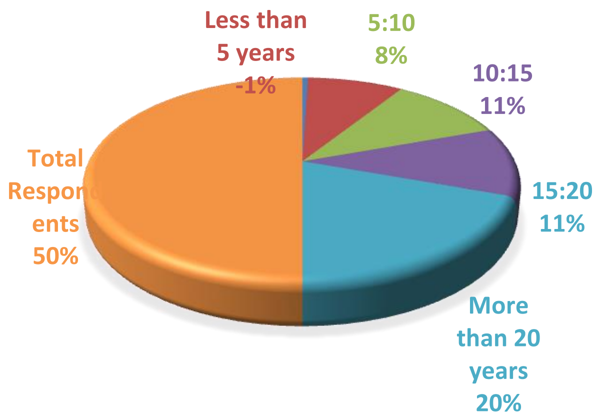
Where:

SS_{corr}: corrected sample size

pop is the population which is considered for this research as the number of construction management engineers in the construction industry in Egypt, the number of pop is 5,000, by using the equation:

$$SScorr = \frac{68}{1+\frac{68-1}{5000}} = 68 \qquad \text{Equation 4.}$$

The questionnaire was distributed to 200 engineers from the target sample, 100 valuable responses were received in two months. Twenty-eight of them were neglected due to uncompleted answers and data. The experience of respondents is illustrated in Fig. 1. The questionnaire aims to obtain the opinions of specialists in project management regarding the questions about the current risk allocation problem statements, sources of risk in construction projects, their impact on the project objectives, and the possibility of their occurrence. The organization type for respondents is presented in Fig. 2. To complete the study, Survey results were described and illustrated using descriptive graphs, charts, and figures.



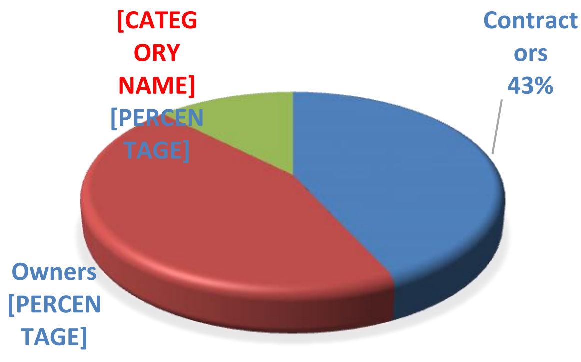


Fig. 1: Respondent's Profile; Experiences

Fig. 2: Organization Type

5. STATISTICAL ANALYSIS OF THE SURVEY

Both qualitative and quantitative data analysis techniques were used for statistical analysis. Statistical analysis for all collected data will be carried out using SPSS Ver.23 software (Statistical Package for the Social Sciences) and the author will use the following statistical tools:

- Reliability of the questionnaire
- Structure Validity of Questionnaire
- Rank the Factors
- Statistical Validity of Questionnaire

5.1 Reliability of the questionnaire

Reliability is a measurement of the internal consistency of the constructed factors. Reliability analysis was conducted using the Cronbach Alpha Coefficient test through the (SPSS) program, to improve the validity of the study hypotheses. Cronbach's alpha for satisfactory reliability is 0.8, any factor with a corrected item-total correlation value of less than 0.3 would be considered rejected (Kien, 2012). Cronbach's alpha value for all factors is (0.956), which is higher than 0.8, according to the analysis. So it can be said that the questionnaire was valid and reliable.

5.2 Structure Validity of Questionnaire

The Pearson correlation coefficient will be used through the (SPSS) program, to test the validity of the questionnaire structure, where the coefficient of correlation is developed between the main fields and all questionnaire fields. The results show that: All relationships between factors are positive, all relations are statistically significant at $\alpha = 0.01$, and have very strong relation (Pearson correlation coefficient $r > 0.5$).

5.3 Rank the Factors

The attributes of the risk distribution were evaluated based on importance and probability to calculate Relative Importance Index, Frequency Index, and Frequency Adjusted importance index.

A. Relative Importance Index (RII)

For both the entire questionnaire and for each category, current risk allocation attributes were ranked individually, based on importance level values by responses from all participants. RII value was calculated as per Equation 5.

RII$=\Sigma W A(N)$ ………………………………………………… Equation 5.

Where,

W = weight given to each attribute by the respondent (1 to 5),

+A = the highest weight (in this case is 5),

N = total number of respondents.

B. Frequency Index (FI)

The value of the frequency index (FI) will be determined, and the existing risk allocation attributes will be ranked based on their frequency scale values by responses from all respondents.

FI%= $\Sigma \boldsymbol{WA}(\boldsymbol{N}\ \boldsymbol{X}\ \mathbf{10}0$ ……………………………………… Equation 6.

C. Frequency Adjusted Importance Index (FAII)

FAII was conducted to rank the risk and get the significant factors. After FAII for risk factors being sorted from largest to smallest index, where (highest FAII) = 49.04, the (lowest RII) = 23.95. Difference (D) can be assumed as a guide for factors classification and can be calculated as D = 49.04-23.95 =5.02. While the intervals are considered to be equal for all levels and Equal to D/5= 0.06 4.8. TABLE 3 showed the significant risk factors after FAII are computed according to previously determined values, to reflect the most significant risk factors affecting the construction projects.

TABLE 3: Ranked FAII Values for Risk Sources

Rank	Factor	FAII	ID	Importance
1	Material delivery doesn't comply with a schedule	49.04	X51	**Very High**
2	False progress reports	47.26	X35	
3	Subcontractor's failure to comply with the schedule	47.05	X45	
4	Procurements problems	45.89	X55	
5	Unclear responsibility matrix	44.25	X6	
6	The ability of productivity of subcontractors	43.97	X49	**High**
7	Indecisive management	43.17	X15	
8	Change scope of work (leads to change contract price)	42.97	X5	
9	Lack of coordination between subcontractors	42.86	X43	
10	Lack of procedure to correct errors	42.75	X16	

5.4 Comparison of Top-Ranked Risks Between the Contractors and the Owners

Table 4 showed the comparison between TOP 10 significant risk factors that affect the group of contractors and the group of owners separately, while Fig. 3 showed the significant risk factors related to those of the group of contractors and the group of owners. From the table it can be concluded that both parties have a belief that there is a problem in the current practice of risk allocation, they have the same concerns about the same risks but with different degrees.

TABLE 4: Comparison Between Significant Risk Factors for Contractors and Owners

FAII Rank	Contractors		Owners	
	ID	**Factor**	**ID**	**Factor**
1	X51	Material delivery doesn't comply with the project schedule	X51	Material delivery doesn't comply with the project schedule
2	X9	Strong competitors	X35	False progress reports
3	X45	Subcontractor's failure to comply with the schedule	X55	Procurement problems
4	X5	Change scope of work (leads to change contract price)	X45	Subcontractor's failure to comply with the schedule
5	X55	Procurement problems	X28	Defective Materials
6	X35	False progress reports	X43	Lack of coordination between subcontractors
7	X49	The ability of productivity of subcontractors	X15	Indecisive management
8	X69	Late issuance of licenses	X6	Unclear responsibility matrix
9	X6	Unclear responsibility matrix	X11	Unreasonable expectations of the client
10	X16	Lack of procedure to correct errors	X49	The ability of productivity of subcontractors

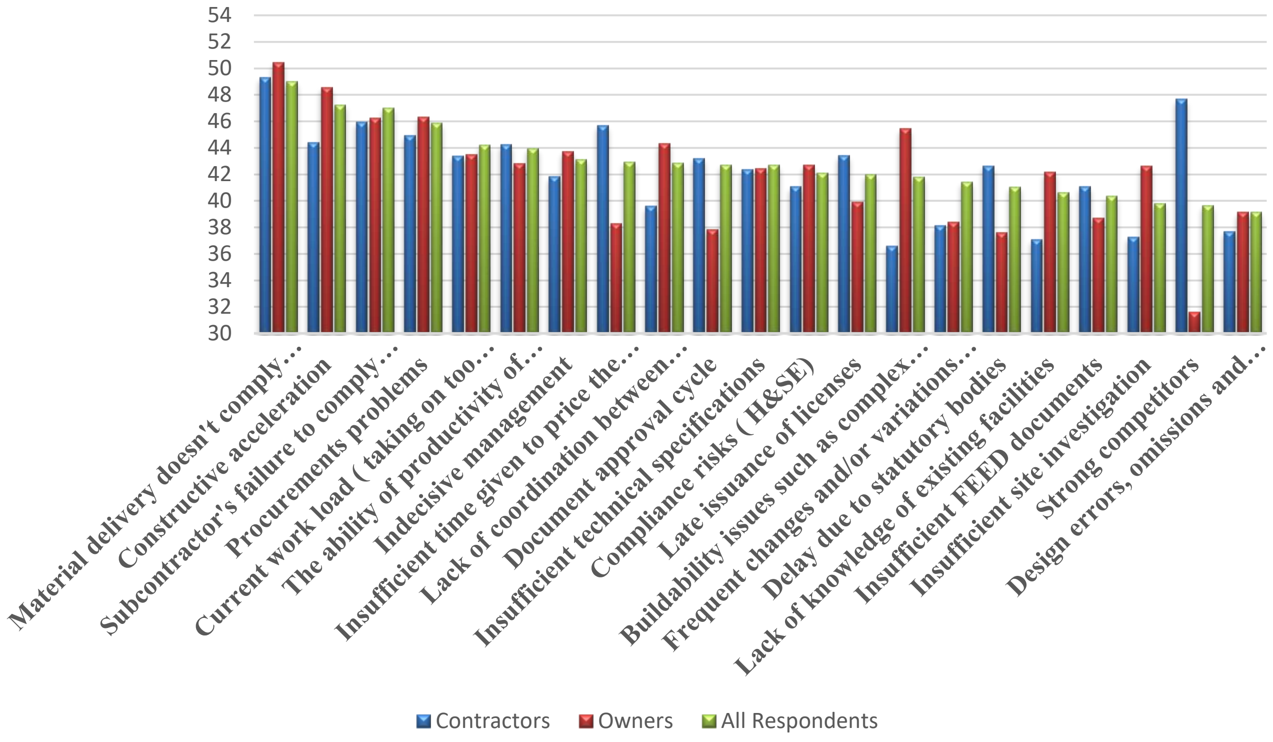


Fig. 3: Significant Risk Factors Related to Organization Type

Furthermore, the factors in each group should be ranked using FAII calculations to reflect the most significant factors in their group as shown in Table 5.

TABLE 5: Pearson Correlation Value of Factors and Their Groups

ID	Attributes		Pearson Correlation	P-Value (Sig.)
X51	Material delivery doesn't comply with project schedule	**Impact**	**.711****	**0.000**
		Probability	**.699****	**0.000**
X35	False progress reports	**Impact**	**.726****	**0.000**
		Probability	**.487****	**0.000**
X45	Subcontractor's failure to comply the schedule	**Impact**	**.633****	**0.000**
		Probability	**.698****	**0.000**
X55	Procurements problems	**Impact**	**.382****	**0.001**
		Probability	**.600****	**0.000**
X6	Unclear responsibility matrix	**Impact**	**.642****	**0.000**
		Probability	**.603****	**0.000**
X49	The ability of productivity of subcontractors	**Impact**	**.547****	**0.000**
		Probability	**.530****	**0.000**
X15	Indecisive management	**Impact**	**.577****	**0.000**
		Probability	**.499****	**0.000**
X5	Change scope of work (leads to change contract price)	**Impact**	**.632****	**0.000**
		Probability	**.594****	**0.000**
X43	Lack of coordination between subcontractors	**Impact**	**.517****	**0.000**
		Probability	**.663****	**0.000**
X16	Lack of procedure to correct errors between owner and contractor	**Impact**	**.615****	**0.000**
		Probability	**.492****	**0.000**
X2	Insufficient technical specifications	**Impact**	**.607****	**0.000**
		Probability	**.513****	**0.000**
X31	Compliance risks (H&SE)	**Impact**	**.662****	**0.000**
		Probability	**.380****	**0.000**
X69	Late issuance of licenses	**Impact**	**.766****	**0.000**
		Probability	**.792****	**0.000**

X28	Defective Materials	**Impact**	**.564****	**0.000**
		Probability	**.627****	**0.000**
X17	Frequent changes and/or variations by client	**Impact**	**.545****	**0.000**
		Probability	**.566****	**0.000**
X70	Delay due to statutory bodies	**Impact**	**.868****	**0.000**
		Probability	**.867****	**0.000**
X38	Lack of knowledge of existing facilities	**Impact**	**.399****	**0.001**
		Probability	**.598****	**0.000**
X7	Insufficient FEED documents	**Impact**	**.392****	**0.001**
		Probability	**.753****	**0.000**
X10	Insufficient site investigation	**Impact**	**.318****	**0.006**
		Probability	**.616****	**0.000**
X9	Strong competitors	**Impact**	**.439****	**0.000**
		Probability	**.447****	**0.000**
X34	Design errors, omissions and contradiction in documents	**Impact**	**.312****	**0.008**
		Probability	**.534****	**0.000**

5.5 Pearson Correlation of Significant Factors

The author will consider that the risk factors affecting construction projects are those classified as very high and high, the analysis found (21) Significant Factors. These factors are taken to calculate Pearson correlation coefficient values to configure the correlation between these factors and are important to determine which factors have a significant relation to other factors that affect the construction project. The results of correlation analysis show the following:

- The risk factor "Material delivery doesn't comply with the project" has a very strong correlation with the risk factors "Subcontractor's failure to comply with the schedule", "Procurements problems", and "The ability of productivity of subcontractors"
- The risk factor "False progress reports" has a very strong correlation with the risk factor "Frequent changes and/or variations by client".
- The risk factor "Subcontractor's failure to comply with the schedule" has a very strong correlation with the risk factors "The ability of productivity of subcontractors", and "Frequent changes and/or variations by the client".
- The risk factor "Procurements problems" has a very strong correlation with the risk factor "Defective materials".
- The risk factor "Unclear responsibility matrix" has a very strong correlation with the risk factors "Change scope of work (leads to change contract price)", and "Insufficient site investigation".
- The risk factor "Lack of procedure to correct errors" has a very strong correlation with the risk factor "Indecisive management".
- The risk factor "Insufficient site investigation" has a very strong correlation with risk factor "Design errors, omissions, and contradiction in contract document".

6. RISK CONTROL STRATEGY

The final section of this research is to compare the proposed responses from the contractors' group and the owner s' group to the response strategy for the 21 most important (very high and high) risk factors affecting project performance. The ways in which each project party has dealt with each potential risk is reviewed and analyzed based on the survey data results. From Table 6. it can be concluded that the two main parties in the construction project have almost the same perspective towards responding to risks.

Table 6: Risk Control Strategy Contractors Vs Owners

Risk Factor	ID	Control risk Strategy	
		Contractor	Owner
Material delivery doesn't comply with the project schedule	X51	Mitigate	Mitigate
False progress reports	X35	Avoid	Avoid
Subcontractor's failure to comply with the schedule	X45	Mitigate	Mitigate
Procurements problems	X55	Mitigate	Mitigate

Unclear responsibility matrix	X6	Avoid	Avoid
The ability of productivity of subcontractors	X49	Mitigate	Mitigate
Indecisive management	X15	Mitigate	Mitigate
Change scope of work (leads to change contract price)	X5	Mitigate	Mitigate
Lack of coordination between subcontractors	X43	Mitigate	Mitigate
Lack of procedure to correct errors	X16	Mitigate	Mitigate
Insufficient technical specifications	X2	Avoid	Avoid
Compliance risks (H&SE)	X31	Mitigate	Mitigate
Late issuance of licenses	X69	Share	Share
Defective materials	X28	Mitigate	Mitigate
Frequent changes and/or variations by the client	X17	Share	Mitigate
Delay due to statutory bodies	X70	Share	Share
Lack of knowledge of existing facilities	X38	Share	Share
Insufficient FEED documents	X7	Mitigate	Avoid
Insufficient site investigation	X10	Mitigate	Avoid
Strong competitors	X9	Share	Share
Design errors, omissions, and contradiction	X34	Mitigate	Mitigate

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-taile).

7. CONCLUSION

This paper concludes that being vigilant about priority risk factors and implementing risk mitigation measures through the terms of the contract can contribute to a consensual relationship between the two parties to the contract, thus ensuring more satisfactory results for the project. The major risks factors in industrial projects were identified based on the literature reviewed and expert suggestions. A questionnaire was developed and distributed to several project management experts to determine the most significant risk factors affecting the project objectives. The results showed that there is a problem in distributing risks in Mega industrial projects amongst various parties. From the study, it emerged that 29% of significant risk factors were due to risk during tender, which means that these risks may be avoided by suitably modifying the contract clauses to ensure that the risks are allocated in a transparent manner. While 25% of significant risk factors were due to design errors, defective material, and Compliance risks (H&SE) these risks can be mitigated through appropriate adjustments to contract clauses for procurement, design review, and quality control, which allow these types of risks to be shared. The remaining risk factors were due to indecisive management and subcontractor's problems; these threats can be mitigated by adding provisions for following up on the progress of project implementation on the part of the owner so that solutions to the obstacles that appear dynamically can be developed.

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