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Assessment of Contract Terms and Conditions for Lump-sum Contracts

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Assessment of Contract Terms and Conditions for Lump-sum Contracts

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ABSTRACT

A Contract is a tool that defines the obligations of the contracting parties and assigns the risk between them. Contracts are usually drafted to meet the interests of the owner by addressing the legal issues and liabilities. Meanwhile, less emphasis is placed on clearly communicating the contract terms and ensuring that all contracting parties comprehend their risks and obligations. In a country like Egypt, which has faced drastic economic and political changes in the past few years, and yet is experiencing a boom in the construction sector, many developers tend to draft contracts that might be legally complicated or lacks proper risk allocation to protect their interests. With the lack of sufficient contract evaluation tools, contractors might fail to identify the contractual risks involved with the project leading to the rise of several claims and dispute that might cause delays to the project. Lump sum contracts are becoming increasingly utilized in construction projects around the world. This is because Lump sum contracts allocates most of the risks on the contractor's burden thus, many contractors may not fully comprehend its provisions nor, implement proper contract evaluation techniques. Accordingly, this research analyses the terms and conditions of 18 lump-sum contracts implemented in Egypt with the objective of devising a contract evaluation method that will enable contractors to analyze a contract and compare the results with previous projects. Each of the studied contracts was analyzed against a list of criteria that were derived from the literature including contractual risks and the factors that cause project delays. The findings create a database of the common lump sum terms utilized in Egypt against which other new contracts can be evaluated. Followed by a two-stage evaluation process, commencing with utilizing Radar charts to compute a contract balance index for every category and analyze specific critical contract provisions of different contracts together. The second stage implements a linear programming technique called Data Envelope analysis to evaluate the entire contract terms together and identify the degree of effectiveness from the Contractor's perspective. The research contributes with a premilitary conceptualization contract evaluation tools. It presents a webtool that computes the Contract Balance index to provide a numerical indication of the related contract terms. In addition, this thesis also computes an efficiency index that can evaluate the entire contract.

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CHAPTER 1: INTRODUCTION

1.1 Overview

Construction in Egypt is a booming Industry and contributes greatly to the overall gross domestic product (GDP) of Egypt. According to Fayed and Ehab (2015) the construction sector being one of the prominent industries in Egypt employs a significant number of labors and engineers, that accounted for 11% of the industrial labor force at the end of the financial year (FY) 2013/2014, thus being one of the top contributing sectors after the agricultural sector. In 2019 the economist Intelligence Unit announced that the real GDP of Egypt for the year 2019 is 5.5%, while it is forecasted that Egypt's economy will grow strongly in the coming years with the construction and energy sectors being the main drivers for growth (ECI, 2019). Along those lines, the Enterprise Press declared during the fiscal year 2018/2019 the construction industry in Egypt demonstrated a growth rate of 8.9% compared to the predecessor year, and with this the construction industry became one of the top contributors to the annual GDP of Egypt, as the construction industry solely contributed with 11% of the economy. In a study conducted by Fitch solutions the growth rate in the construction industry in 2019/ 2020 was 10.3% which was considered the second highest in the MENA region (Al-Aees, 2019). This growth rate influenced experts to forecast that the Egyptian construction industry will be valued $5,355.4 million by 2021 (Ibrahim, 2019)

Being one of the most dynamic industries in Egypt, the construction industry strongly affects the country's economic and political conditions, keeping it striving during various hardships (Khodeir & Mohamed,2015). Accordingly, the Egyptian Government and nation, after being faced throughout the last decade with three major, closely spaced events, the 2011 and the 2013 revolutions along with the fluctuation of currency in 2016 (Writer, 2017), are rallying around the construction industry with the hopes of emerging of this state of political instability and economic turmoil. Consequently, many of the construction projects during this phase were affected, several labor and material costs have increased as fuel prices increased. These incidents led to the rise of several claims and disputes amongst contractors and developers (Magdy et al, 2019). In addition to placing unanticipated burden on contractors and developers to revisit their contracts terms and conditions for effective allocation of risks between the contracting parties.

Companies and organizations in Egypt and abroad, during the course of their operations, enter into contracts with suppliers, vendors, employees, customers, and other stakeholders, while this is no different for construction companies. Almost every construction project involves drawing up contracts between the developer/employer itself and the contractor, suppliers, vendors, etc. The contract documents usually incorporate the main contract conditions, and any specific conditions related to the nature of the project. These documents are the main instruments that define the scope of the work, the responsibilities, and the expectations of the involved organizations or parties. In other words, it lists of all the terms and conditions that were agreed upon by the contractual parties and help in allocating the various risk to the contracting parties.

Contracts, being agreements that are legally binding, have particular wording that at times might be challenging to comprehend. Understanding the terminology of contracts & the risks imposed, would be helpful in supporting project managers and business owners in managing their legal relationships in a better way. Each of the contracting parties tend to protect their interest and maximize their benefits VIA the contract terms and conditions (Zacks, 2015).

While the employer and contractors share the same goal, which is to complete the project without any cost or time overrun, their exists some differences in their benefits. According to Jeffery Ottesen (2016), the differences between the objectives of the employer and the contractor can lead to several disputes throughout the course of the project. This can be demonstrated by the fact that the employer's objective is usually to obtain the best price, minimize changes and conclude the project on time. While the contractor's main objectives are to maximize profit, capitalize on change orders and reduce the overheads by completing the project as early as possible. With this in mind, disputes throughout the project are most likely inevitable (Ottesen, 2016). This raises the need for a clear contract that can determine the parties' objectives and liabilities and highlight the importance of revealing each parties' interests during the tendering and negotiation stage (Zacks, 2015).

Consequently, the employer being the drafting party tend to formulate a contract that protect his needs with some flexibility, and the least exposure to his liabilities (Zacks, 2015). In a study conducted by Elisabeth Viles (2019), 1057 causes of delay were gathered from literature, and analyzed by frequency of presence, in order to identify the most affective causes of delay that significantly impact the project performance. It was discovered that one of the major causes

affecting the project duration is the continuous variations during the construction phase, Thus the drafting party attempt to protect its interest with contract terms and conditions that does not impose major liabilities for its modifications (Viles, 2019).

At this point, the employer is in preparation of a contract that is protecting its interests at the expense of the contractor while, if it is signed without being clarified or modified, will specify, and govern the legal obligations of the two parties (Zacks, 2015). The drafting party is usually able to control the exact language that will be used in the contract, and this is inclusive of how the language is used to define and describe the different promises. The contractor being the non-drafting party, tend to examine the contract documents from a more technical perspective, with the interest to receive the benefit of the project. The contractor in this case may approve a contract to secure the project with less awareness of the legal risks and burdens existing in the contract. Thus, if the contractor is unable to detect and evaluate the contractual risks enforced in the contract, the contractor pricing may not be accurate, putting the project at risk of cost & time overrun.

1.2 Problem Definition:

Effective contract evaluation plays a central role in the success of a business, while this is the reason why many employers and contractors tend to spend significant amounts on managing and reviewing diligently these documents to make sure that effective contracts are drafted. The process of drafting an effective contract that meets the interest of both parties can be time consuming and costly, especially if one of the parties resolves to a third party to review the contract and identify the contractual risk. Furthermore, the contract wording is another major issue that can lead to several disputes. According to Clough (1986), a contract that is well worded has to offer a precise description of the financial, legal, and technical sense of that particular project.

Consequently, in lump sum contacts if the contract wording is not clearly selected, there could arise various potential challenges. For instance, the clauses might not be enough to assign risks explicitly and clearly among the involved parties in a manner that is equivocal. Inaccurate contract wording might also fail to address the contracting parties' preferences. Additionally, it is impossible for the standard clauses to fulfil the users' needs when the interpreted risk allocation fails to coincide with the allocation that is preferred. This section presents below a brief description of the main issues in contracts evaluation that are analyzed in this research.

1.2.1-Use of complicated legal terms:

Contracts, being legally binding, have wording that at times might be challenging to comprehend. Understanding the terminology of contracts would be helpful in managing the legal relationships in a better way. Additionally, parties entering into an agreement may not be aware of the legal implications of certain terminology even when the terms can be understood. According to Korobkin (2013), the parties' have varying interests, and the employer's ability to act in their own interest with respect to the contract preparation could only prove to be an issue if the contractor fails to detect the self-interested behavior of the agent. For instance, if the contractor can read and comprehend the agreement and its legal implications, then, the contractor might have the ability of detecting if, in fact, the employer prepared the written document in their favor. Nevertheless, in numerous cases, it could be hard to track or verify the behavior of the drafting party. For instance, if the agreement is written in a legalistic language, rendering it hard to comprehend what is actually meant by the written contract (Korobkin, 2013).

1.2.2-Poor Risk allocation in contract:

Poor risk assignment due to the use of vague or unclear terms and phrases can lead to various disputes throughout the course of the project. As Hartman and Snelgrove (1996) put it, the ability of a contract to assign risks clearly between the involved parties in the contracting process is among the measures of the effectiveness and efficiency of a contract. A clear risk assignment implies that the involved contracting parties understand the risk management accountability and risk appointment in the same way. The impact of the results of mismanaged risks on the execution of the project ultimately increases the costs of the project (Hartman, 1993). For instance, several contracts may incorporate an acceleration provision, where is entitles the owner or his representative to instruct the contractor to increase the labor and equipment in order to mitigate any delays. Such instructions shall be followed meticulously by the contractor. However, it does not protect the contactor's entitlement to claim for any compensation. Furthermore, these general provisions did not tackle the fact that the delay may be caused by the Employer, hence the acceleration cost shall not be borne by the contractor. Accordingly, a slight modification to the acceleration provision by adding a sentence "the contractor may be entitled to any extension of

time or extra compensation in accordance with the variation orders section" can regain the balance of risk in this provision between the contractor and the employer (Ottesen, 2016).

1.2.3- Unaddressed contractual risks:

In several occasions the contract language might fail to allocate all the risks to its corresponding party. In a case study presented by Ottesen (2016), for the construction of a state college campus, the contract specified a minimum duration of 20 working days for the review period by the owner for each submittal. However, the contract remained silent regarding the maximum duration that can be exhausted by the employer before the contractor can claim extension of time. Such provision held the contractor in a disadvantaged position, as is difficult to expect the contractor to await this duration for every submittal. Jeffery states that such contract provision places the owner is a more favorable position without the contractor noticing (Ottesen, 2016).

1.2.4-Contract Lacking Clear Procedures:

Usually contract documents incorporate the procedures to be followed by the contractor in dealing every issue in the project. For instance, most contracts tend to include a procedure for the submission of claims, variations, drawings etc. lots of conflicts can be resolved by specifying and documenting the contractual procedures (Yu Maemura, 2018). In a study conducted by Yu Maemura (2018) on the construction of a sewage system in the city of Ho Chi Minh, it was acknowledged that negotiation and documentation of all the necessary procedures during the pre-contract stage were the keys factors for the success of the project. For example, clearly stating the payment procedures and management of delayed payments along with the process for submitting and reviewing the variations etc. prior to entering into an agreement clarifies most the risks that might face the contractor. Hence, when parties' interests are clear as they agree on the interpretation of the contractual clauses and their procedures, conflicts can be diminished at an early stage (Yu Maemura, 2018).

1.2.5-Inability to evaluate contract terms:

Ideally, contracts were drafted and evaluated by lawyers, to ensure all legal aspects are covered, however this is not the optimum case. Contracts that are drafted with only legal articles and responsibilities in mind do not support the dynamic nature of the industry, which has shifted to enhance the contract communication between parties using more innovative techniques (Passera et al, 2017). The International Association for Contract & Commercial Management (IACCM) attitudes to contracting shows that the utilization of contract as a legal document to defend a party rather than an instrument of communication and understanding is the main cause of cost overrun and project delay. On the other Hand, 90% of the business readers find the contracts hard to read and understand (IACCM, 2015a). Therefore, research have been conducted to try to simplify contract language and attempt to utilize innovative contract evaluation & representation methods to analyze and identify the contractual risks. Examples of such research are the simplification of contract language and design (Kimble, 2002), visualization (Jones & Oswald, 2001), collaborative contracting (Barton, 2012), and Contracts as interfaces (Passera & Haapio, 2016).

To conclude, the presence of a contract evolution process is critical to be able to detect any issues in contract drafting during pre-tender stage. many contractors might also lack enough time to go through a lengthy agreement to determine and put into consideration the implications behind every provision. Meanwhile, the contract evaluation process heavily relied on the experience of the management in construction in an attempt to tighten up the contract terms for issues faced during their years of experience. However, there are a few studies that focus on analyzing contract terms and comparing the results to be able to identify a list of legal and contractual terms that needs to be defined. In addition, contracting parties nowadays tend to employ engineers and managers to administrator the contract process, who require the need to demonstrate the contract information in a more straightforward and innovative way, which can help better understand the contract terms.

1.3 Research Questions

1. How can the terms and conditions of contracts be analyzed within the risk management policies in construction in Egypt?
2. What are the most common terms and conditions implemented in Lump Sum Contracts in Egypt?
3. How to measure & evaluate the risk in lump sum contracts?
4. Can contractual terms be classified? And how can contractual risks be quantified without relying on subjective methods?
5. How to evaluate an entire contract and identify if the contract terms are favorable to the contractor?

1.4 Research Objectives

By addressing the research questions, this research's main objective is to develop the contract evaluation procedures implemented by contractors and utilize linear programming & visualization techniques to better understand the contract terms. In order to reduce the number of disputes and ensure contract parties are meeting their obligations, it is crucial to be able to identify the contractual risk. Therefore, studying the contract evaluation techniques and implementing them on the Lump Sum contracts in Egypt, shall demonstrate the optimum technique to be implemented in analyzing and quantifying the contractual risk.

1.4.1-Sub-Objective 1: Identifying the Contractual Risks and causes of delays:

The first objective of this research is to identify from literature the contractual risks discussed, and the factors that affect the project cost and time. In addition to emphasizing on the causes of delays that face contractors in Egypt. This concludes with a list of risks and causes of delay which enable contractors to efficiently evaluate new contracts during tendering stage. Contractors shall be more aware of the common contractual risks faced and will be able to identify any issues in contract drafting.

1.4.2-Sub-Objective 2: Analyze the terms and conditions of Lump-Sum Contracts:

The second objective is to analyze collected contracts conditions and identify the common terms and conditions of the lump sum contracts that are implemented in Egypt. The results of the analyzed conditions are compared to be able to get a contractual overview of the construction sector in Egypt. The contract conditions are classified to groups and sub-groups to be able to quantify the risk. Knowing these conditions will enable contractors during the tender phase to create a detailed analysis of the contract terms implemented in Egypt with that of the new project. This concludes with a list of all contract conditions implemented for each clause and the common provisions.

1.4.3-Sub-Objective 3: Evaluation of the contract terms and condition:

Finally, this research reviewed the several evaluation techniques along with the visualization techniques used in representing the contract terms and presents a new method to compare the contract terms and conditions in contrast of a new contract with the common conditions that were previously analyzed from the contracts in Egypt. The utilization of linear programming method and graphical tools will enable to quantify the risk (Contract Balance Index) and comparing the terms of conditions of the contracts.

1.5 Scope of Research

The scope of this research shall be limited to analyzing the terms and conditions of the Lump sum contracts in Egypt. In addition, the owner companies and the EPC contractors have been considered as the main contracting parties in the scope of this research. The contracts scope covers engineering, procurement, and construction (EPC) phases. The type of the projects includes residential, commercial, industrial and infrastructure works. Contracts are mostly assessed from the perspective of the contractor since lump sum contracts tend to impose high risks on the contractors, while they may not have the leverage to modify the contracts terms and conditions. The study incorporates the analysis of 18 lump sum contracts against a set of criteria to identify the most implemented terms and conditions. Radar charts are used to analyze and compare contracts terms of the same category together, while Data envelope analysis will be implemented to analyses the entire contract terms.

1.6 Research Methodology

To achieve the objectives of this research and to be able to create a reliable contract evaluation tool that would be applicable in the Egyptian market, four stages were implemented including literature review, data collection and listing, analysis and program creation, and findings. Figure 1 illustrates a summary of this research approach and purpose of each phase implemented.

Firstly, the literature review stage was crucial to understand the contractual risk affecting the construction industry. In this stage different contract assessment techniques were studied along with collect and compile any the contractual risk and any assessment templates (Cronje, Gretha, et al, 2013), in addition to the other causes of delays and disputes mentioned in literature that are related to contracts and specifically those in project in Egypt. This stage shall be concluded with a list of all the contractual risk that will further be developed in the following stages to emphasis on lump sum contracts.

Secondly, in order to identify the contract provisions that suit the construction industry in Egypt, it was essential to identify the main contract provisions utilized in the country. Thus, an earlier research conducted by El Hoteiby (2016) at the American University in Cairo was utilized, in which the researchers analyzed 28 construction contracts in Egypt and was able to define 102 critical provisions which must be defined in every contract to avoid disputes and to ensure a contract is complete and that all the risks are allocated to a party. Together these provisions paired with the criteria retrieved from the literature, as well as any special conditions that were extracted from the contracts analyzed, provided the base criteria for this research's database.

Thirdly, to further focus on lumpsum contracts, this research collected and analyzed 18 Lump sum contracts for construction projects in Egypt, were the terms and conditions of each contract were recorded against the list of criteria gathered in the earlier stages. The gathered criteria are classified to section incorporating critical provision. The collected data were further classified to either numerical results, binary, or optional item with several conditions collected from the various contracts. Subsequently, each of these groups are analyzed for instance, the numerical results are statistical analyzed to compare the results of each item. While binary groups are analyzed to calculate the frequency of occurrence in all the contracts gathered. Finally, the optional

items (Provisions that have several wording options) are discussed based on the severity of their risk, along with analyzing the percentage occurrence of each if any. This analysis shall reveal the common Lumpsum contract condition used in the construction sectors in Egypt and the severity of each.

Successively, the contract evaluation techniques presented earlier in literature are reviewed and the various methods utilized to analyze the contract information are identified. Radar charts being one of the most popular methods for comprehensive performance evaluation is reviewed to be implemented in this research, in addition to studying the possibility of implementing linear programming methods to numerically analyze and rank how favorable are the contract terms to the contractor. Finally, a platform is created incorporating all the collected data from the contracts along with the analysis conducted on them. The platform utilizes this information as a method of analysis and comparison with the new projects. The radar chart created for each section of the contract is to enlighten the user with the risk Index for each division solely, while this risk index can be compared to the previously analyzed contract to be able to effectively evaluate the contract. Moreover, several statistical charts shall appear for each item to demonstrate the strengths and weakness in the contracts. Lastly, the user shall be able to identify the risky items in each section along with evaluating the entire contract sections for a more educated decision during the negotiation stages.

This research method shall assist in understanding the terms of the lump sum contracts along with identifying the most common terms and conditions implemented in construction projects in Egypt. This research contributes to the evaluation & visualization of contracts research. the evaluation method presented in this research can be used by contractors, to review, asses and graphical analyze the lump sum contracts.

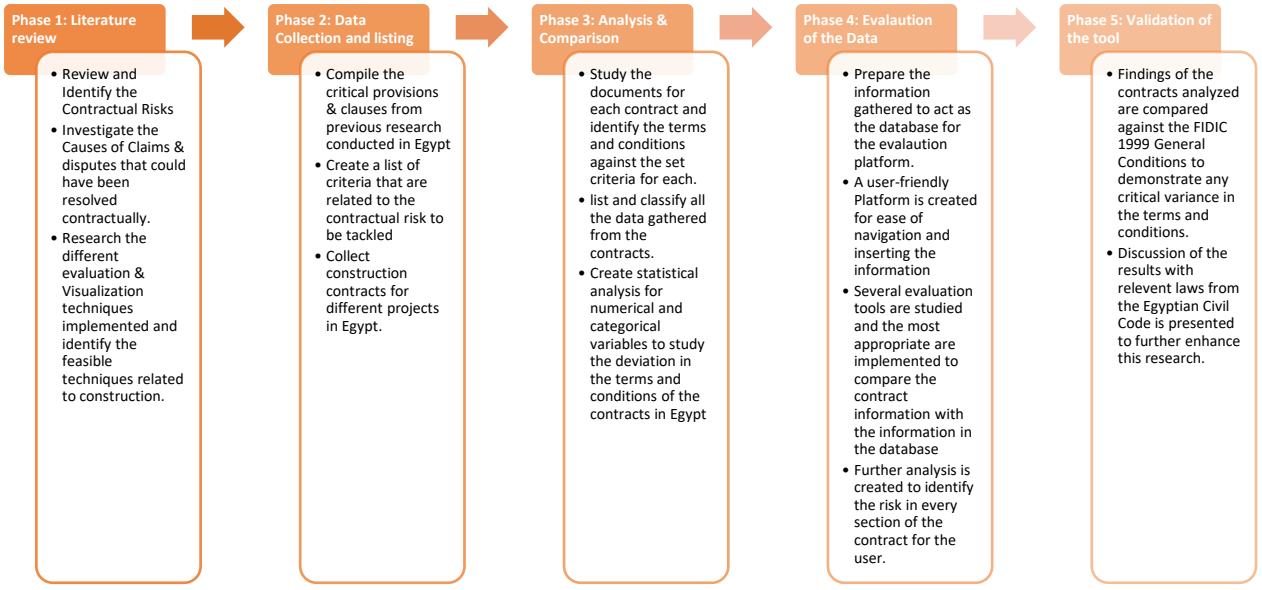


Figure 1: Research Methodology

1.7 Thesis Organization:

The thesis consists of six chapters beginning with chapter 1 covering the background of the research and of the economic and political situation in Egypt. The problem definition and the purpose of the research followed by the research questions. Then the objectives of the study are defined along with defining the relevant scope of the study. Finally, it is concluded with the research methodology and the thesis organization.

Chapter 2 covers the literature review and is divided to two sections. This literature review presents an extensive study of the contractual risks, the contract evaluation techniques and emphasizes the importance of contract wordings. In addition, this chapter presents the several techniques of contract evaluation & visualization in literature and examines the applicability of radar charts as a method of visualization.

Chapter 3 discusses in detail the methodology implemented in the research to accomplish the research objective are described. It also discusses the definition, and the characteristics of the lump sum contracts. Moreover, it displays the selection criteria for the projects to be evaluated, the data collection and analyses methods to be applied for the research.

Chapter 4 presents the statistical analysis of the 18 lump sum contracts gathered after inserting all the required criteria. It discusses the results of a probabilistic analysis model that were conducted on all the items. It further discusses the results of the common conditions implemented in Egypt in light of the FIDIC 1999 provisions and with the relevant laws of the Egyptian Civil Code. Although the FIDIC 1999 standard contract addresses remeasured contracts, it was observed that it is vastly used in construction in Egypt and is modified in several projects to suit their Lump sum nature.

Chapter 5 discusses the results of the two-stage contract evaluation method in details it presents how the Radar charts are used to present the contract information and to calculate the Contract balance index for every group of contract provisions. It further discusses the results of the Data envelope analysis in evaluating the entire contract and how it can help the contractor identify if the contract conditions are favorable in comparison with the previously analyzed contracts.

Chapter 6 presents the conclusion of this research along with the limitations of the study. In addition to providing with recommendations for future research that can use the same methodology and compare the results. (see table 1 below for diagrammatic illustration of the thesis organization)

Table 1: Thesis structure

Thesis Organization	**Chapter 1:**	**Covers overview, Problem Definition, research Questions, Scope, Methodology, and organization**
	Chapter 2:	**Literature Review about: Contractual Risk & causes of delay, Contract evaluation and Visualization of contract terms**
	Chapter 3:	**Research Methodology & discussion of the Lump Sum Contracts.**
	Chapter 4:	**Analysis of the gathered Contracts, demonstrate Statistical results of the conditions implemented in Egypt, and comparison of results with FIDIC 1999 and ECC.**
	Chapter 5:	**Calculation of Contract balance Index, and development of databases to assess a group of contract provisions. Development of Linear programming model to evaluate the entire contracts.**
	Chapter 6:	**Conclusion of the research, Discussion of the research Question Answers & Limitations of the Study.**

CHAPTER 2: LITERATURE REVIEW:

2.1 Introduction

This chapter aims to understand the contractual risks discussed in various research, their origin, cause and how to manage such risks followed by discussing the contractual risk management techniques. Subsequently, this chapter explores the contract evaluation methods presented in literature and the possibility of using visualization techniques along with other methods to analyze the contractual risks.

It presents the findings from literature regarding the contractual risks and the contract risk management. The first section of this chapter commences with presenting the functions of the contract, followed by how the contract is perceived as a source of risk and how it can act a risk treatment device. Subsequently, it presents the contractual risks documented in literature along with the causes of disputes that can be avoided in the contract terms. The second section of this chapter presents the importance of contract evaluation and the initiatives undertaken by researchers in this field. Moreover, it studies the suitability of radar charts and the presents how it was implemented in different research. In addition, this chapter concludes with a list of contract term that shall be used in the following sections of the research.

2.2- Contract Risk and Contract Risk Management

2.2.1- The four research perspectives

Contract and management come from varying domains of science where they both encounter one another in business. Construction projects continue to be faced by contractual disputes that raises the need to constantly develop the risk management dimensions of the contract. In this respect, researchers have been focused on studying four fields of contract management and which most of the literature review tend to address (Schuhmann and Eichhorn, 2016) . These four fields of interests are as follows:

1) The managers attitude toward contracts, this occupied a significant amount of researcher's interest. According to Haapio et al. (2012), a contract is first viewed as a legal instrument, this displays a stress on legal implications of the contract (IACCM, 2014). Managers might consider these contracts to be burdensome, superfluous, or also hazardous (Haapio et al. 2012). Managers are less likely to fully read the contracts because of their juristic appearance, and they mostly never fully understand the contract (Chong and Zin, 2010).
2) The second research field concerns the economic relationship between contracts and risks. The science of legal and economics states that there is a close and interdependent relationship between contract and risk. While some authors view risk as a substantive criterion which is the core of contract formation (Schuhmann and Eichhorn, 2016). Thus, contractual risks are considered by a lot of companies as a major concern area for its interdependent relationship with their economy. Researchers have been trying to analyze contractual risks from an economical perspective.
3) contractual risk management is another important perspective. Literature on management of risks tend to define contracts as tool for risk transfer and allocation. However, it does not utilize it for this particular function. They offer no procedure on how corporate risk management can be used in the information of the contract. A lot of authors from practice, discuss the use of contract in risk allocation without any reference to theoretical basis (Schuhmann and Eichhorn, 2016).
4) Risk management and contract management is the last perspective addressed in literature. According to a survey by BearingPoint (2010), organizations view the management of risk as the number three priority among the 18 roles of contract management. This is due to the fact that many companies lack a clear risk evaluation procedure prior signing a contract. Hence research have been trying to develop a proper contract evaluation procedure.

To summarize, most of the literature review studied tend to focus on one aspect of the above perspectives. Meanwhile a contract can neither be understood as instruments of management solely nor tailored to be used as such. Hence this research is focused on improving the manager's perspective in dealing with contracts by trying to extract and simplify the contract information. In

addition, it attempts to improve the risk identification allocation process in contracts and provide a contract evaluation procedure that can be used by companies for future projects.

2.2.2- Contract risk management

Keskitalo (2006), Mahler (2007), and Brodermann (2012) explain that the contract's risk dimension is currently understood dynamically from the perspective of risk management. The contract is perceived relevant from double perspectives, that is, as a source of risk and as a device for risk treatment. A contract is perceived as a source of risk because of the consequences that each party faces in case of a breach of the agreement, while it acts as a device of risk treatment when it clearly states the roles of each party involved, therefore reducing the possibility of disputes. The theory of contract basically considers the contract role in sharing the risk.

The risk dimension of contracts has continued to be explored increasingly since the 1970s. The two regulatory contractual dimensions that were recognized by Macneil (1978), are the risk planning and performance planning. According to this recognition, a contract explains the two: the actions that could be taken at the time of an event that hinders the successful execution of the contract (the factors and steps that can make the execution of the contract easy and successfully), as well as the performances that will be impacted by the parties. The risk concept in contracts indeed goes deep into the process of performance planning and different authors explain that most, if not all of the contractual stipulations have a risk dimension (Haapio and Siedel, 2013; Coates, 2012). Long term contracts and construction contracts are an example that can demonstrate this because their subjects are differently categorized. The subjects can be grouped into four categories: obligation and counter-obligation (performances of the contract), uncertainty (environmental impacts and performance impediments), cooperation (procedural process), and general requirements (form conditions, choice of law, and contract language among others).

According to Macneil (1978), the uncertainty domain has often been assigned to planning of risk by the legal sciences. Additionally, how the contractual partners behave might be deemed as a risk of transitioning success if the collaboration act of the partner is needed. According to Haapio and Siedel (2013), the procurement strategy decision, the description of performance that was chosen, the pricing type, or the payment terms, all result from the consideration of tradeoff

between risk and opportunity. Lastly, the regulation subjects that are attributed commonly to the general conditions could be included through the risk concept too. These details evidence that one can understand the content of an agreement through assessment of risk. From this the significance of contractual risks is emphasized, while it is crucial to fully comprehend the contract role in risk management and how the contract is perceived as a source of risk and as a risk treatment device (Schuhmann and Eichhorn, 2016).

2.2.2.1- Contract as a Source of Risk

Although recently a contract is perceived a source of risk however neither a common understanding nor a best practice has yet emerged, the contracts continue to be handled and perceived as a source of risk. According to Segal (2008) and Mahler (2010), perceiving and handling contracts as sources of risk is evidenced by the fact that risks are sometimes associated with the causes, and at times with consequences of an event or even with factors that influence the development of risk. In highlighting the whole potential of management of the contract, and particularly its proactive abilities, Schuhmann and Eichhorn (2016) bases the understanding of risk on the conceptual triad "source of risk – event – outcomes."

Contractual risks are mostly attributed to legal risks. However, there are a number of researches that address legal risks while only a few on contractual risks. There are numerous definitions of legal risk offered by literature as described by Mahler (2007). However, they all agree that legal risk encompasses negative deviations from what is expected of a stakeholder and that might be influenced in one way or another by the law. Mahler (2007) in his research analyzed the definitions of the term legal risk as given by the literature and he comes up with a definition that legal risk is the manifestation of a legal potential detriment of norm. Alternatively, the legal norm could be either the original cause of the risk or a factor of impact on a situation of risk that lacks a legal clause (Mahler, 2007; 2010). The term legal risk also encompasses procurement risk, corporate governance risk, and most often, contract risk. Legal risk has various typical referrals, which include liability on a company, changing of law, infringement of intellectual property, tax code changes, approval risk, fines, change of norms, nationalization/ expropriation, unclear legal situation, among others (Mahler, 2010). All the above factors could rightly be classified as either being the sources of risk or factors of risk impact, and therefore, they all fall among the broader legal risk definition.

Few researches have dealt with the contractual risks. Haapio and Siedel (2013) defined it as “the possibility that the contract leads to a negative deviation from the expected business outcome”. This definition can be broken down to two main aspects, the first is the business outcome, which emphasis the importance of the transaction itself in risk assessment. The second part of the definition is concerned with the how the contract can lead to a negative deviation, which makes the contract a source of risk. Hence, the contract has three contractual functional dimensions, these functional dimensions of the contracts are discussed in detail as follows (Schuhmann and Eichhorn, 2016):

1) Securing legal positions
2) Generating Transparency
3) Stabilization of the Parties relationships.

Firstly, securing the legal positions and safeguarding their interests, It reflects the understanding of the contract as a legal instrument to be enforced and therefore protecting the interests of a certain party (De Jong and Woolthuis, 2009). The terms of a contract can be phrased in such a way that they protect various interests of the involved parties before court to ensure that no rules or regulations are not violated. Such function is crucial for every business to avoid any liabilities or threats on any party.

The second dimension is generation of transparency that relates to the task of the contract to unambiguously define the contributions of the involved parties towards the success of the contract and the connected risks. This is linked to the function of the contract as a risk allocation tool, in which the contract terms should be comprehensive such as to fully cover the expected risks and assign these to their respective party. Moreover, generation of transparency can be reflected in different ways such as visual representation or wording of the contract terms and provisions which is many researches have discussed its importance in ensuring all parties understand their obligations.

The third dimension is stabilization of the relationship of the parties. The contract has to foster and secure cooperation between the involved parties. This can be a source of risk if the contractual co-operation model used does not suit this business i.e., the use of standard contracts or templates which are not tailored for the task and do not clearly define the relationship between the parties may impose a source of risk (Schuhmann and Eichhorn, 2016).

2.2.2.2- Contract as a device of risk treatment

The second function of the contract in contract management is as a risk treatment device. According to Lam et al. (2007) the contract functions as a risk allocation tool which focuses on attributing and dividing the responsibility that is connected to a possible gain or loss in the future. As stated by Lam et al. (2007) and Arinaitwe (2014), a contract is viewed as the most essential instrument for this role. Risk allocation is the concept that the lawyers use in designing and analyzing contracts (Downie, 2012; Arinaitwe, 2014). On the other hand, corporate governance has experienced the development of contract risk management (Krappe and Kallayil, 2003). Contract risk management is focused to identifying and managing risks that might arise from a contract (Trzaskowski, 2006; Mahler, 2010) this is usually concerned with clarifying the terms and conditions of the contract and using more precise words that reflects the interest of the parties, in addition to placing terms that act as a risk treatment instrument. For instance, most contracts incorporate a liquidated damages clause which occurs as result in breaching of a contract, for example, in delay (overrun of time that is caused by the contractor). To prevent damages liability, one has to avoid delay by all means, not the clause of liquidated damages. On the other hand, a clause such as this plays the role of a risk treatment instrument.

2.2.3- The Main Functions of Contracts

There is a consensus that the main function of a contract is supporting the coordination and controlling the behavior of the involved parties (Faems et al. 2010). For instance, for any relational role, the contract acts as control function, while for the performance risks that are related to the task descriptions and the interpretation of the contract, the contract usually functions as co-ordination. On the other hand, performance risks that require future modifications for certain events, the function of the contract is to allow for adaptation. (Chen et al, 2018).

2.2.3.1- Control

The contract controls the actions of the involved parties through stipulation of rules, allocating risk ad defining obligation through contracting with an aim of lessening the opportunism of hazards. The contract clearly divides the rights and obligations of each partner, while also penalizing the behaviors breaching the stipulations of rights and obligations. The contractual control function is divided into four categories: allocation of rights, obligations, penalties, and adjudication (Wang, Wenqian, et al. 2018).

Regarding the allocation of rights, Henisz et al. (2012) asserts that the studies of project governance following the perspective of economy are likely to evoke or constrain the behaviors of the participants. Construction contracts may incorporate clauses that divides the risk between parties and assign risk of certain events to one party. For instance, discovery of underground fossils or antiques is a risk that may be borne by the contractor. The second is the specification of obligations, which specifies with clarity the responsibilities of partners that have to be fulfilled to constrain opportunism. The FIDIC 1999 Standard contract incorporate a provision for contractors' obligations that specifies what is expected from the contractor throughout the project. In this manner, therefore, the contractual parties are controlled in that they have to commit themselves to the obligations or commitments. Additionally, a contract is backed with penalties that make it easy in detecting and dealing with any form of divergence from the agreement. Liquidity damages clause is an example of such provisions that state the penalties in case the contractor failed to deliver the project on schedule. (Henisz et al. 2012). On the part of adjudication, the agreement also employs a third party to be supporting the control functions.

2.2.3.2- Coordination

A contract can also function in coordinating transactions, while also promoting efficiency. In an attempt to achieve effectiveness and efficiency, there are various mechanisms that a contract adopts for communication and clarifying expectations of the division of labor and task objectives. The four categories of contract coordination are: task description, communication, positional power, and interpretations. Task description are the mechanisms that are used to clarify the tasks and roles of the partners (Henisz et al. 2012). Lack of clarity in describing these tasks in the contract would result to a failure on the part of partners in accomplishing their work even when cooperating fully as they would fail to clearly understand what is expected of them.

Similarly, Positional power states the authority of every partner and declares their powers in several situations. Positional power is intended to eliminate any role ambiguities rather than safeguarding the investment and allocating risk (Wang, Wenqian, et al. 2018). The third category is defining the means of communication to be used between the parties. Most contracts constitute a communication provisions that are helpful in avoiding any miscommunication. Regular communication between the partners improves the understanding of the working progress and ability of the other party. Lastly, the interpretation of the contract documents may at times by challenging, this is because contract agreements are usually lengthy and contains legal information. Hence, an agreement includes various provisions as compliments to interpret the stipulations of the contract, for example composition of documents, definitions, and qualifications of personnel. (Wang, Wenqian, et al. 2018).

2.2.3.3- Adaptation

A contract also ought to be flexible in adapting to contingencies that might arise in the future. Contract adaptation is the ability of a contract to handle the changes that might occur in the future effectively and flexibly. Contract adaptation can be divided into either environmental changes or task changes based on the kind of the event. Environmental changes are those changes that happen outside the partners or transactions. These changes include floating exchange rates resulting from a change in the economy, restrictions of labor because of legal changes, and the development of technology because of changes in technology (Henisz et al. 2012). Because these risks might not be evident at the start of the project, the agreement should have a mutually agreed tolerance zone to deal with these unforeseen changes. The task changes, on the other hand, are the changes that might happen during the progress of the transaction after the partners familiarize with the products and technology, and therefore see the need to make various adjustments to the original agreements. For instance, a contractor might come up with different construction arrangements that are cheaper and reduce the cost of works for the employer while obtaining the same result. Additionally, a contract should offer guidelines for Value engineering on how these task changes will be coped with if they should happen along with providing incentives for the contractor as a result of such action (Chen et al, 2018). Table 2 demonstrates the functions of the contract with example.

Table 2: Functions of a contract

Contract Functions:	Control:	Co-ordination:	Adaptation:
	1) Allocation of Rights	1) Task Description	1) Environmental Changes
	2) Specification of Obligations	2) Positional Power	2) Task Changes
	3) Penalties	3) Means of Communication	
	4) Adjunction Mechanism	4) Provisions for Interpretations	
Example of Similar Contract Provision from analyzed contracts:	Inspection and Testing Provision: *"The Contractor shall uncover any part of the Works or make openings in or through the same as the Supervision Consultant may instruct and shall reinstate and make good the same to the satisfaction of the Supervision Consultant. If any such part of the Works has been covered up or put out of view is found to include defects, the Costs of uncovering shall be determined by the Project Manager"*	Disruption of Progress Provision: *"The Contractor shall give written notice to the Project whenever planning or progress of the Works, is likely to be delayed or disrupted unless any Drawing, instruction or approval is issued by the Supervision Consultant or the Project Manager (as applicable) within a reasonable time"*	Force Majeure Provision: *"If a party is or will be prevented from performing any of its obligations under the Contract by Force Majeure, then it shall give notice to the other party of the exceptional event constituting the Force Majeure and shall specify the obligations, the performance of which is or will be prevented. The notice shall be given within fourteen (14) days after the party became aware, or should have become aware"*

2.2.4 Classification of Construction Risk:

Risk classification can be defined as a categorization and reasonable breakdown of the risk identification. It is of considerable importance that the project risk be classified in managing contractual risks as the risks that are involved in the construction industry are varied and diverse. According to Yan (2006), the risks can be grouped into three types, and these are: country risk, government risk, and project risk. The country risk comprises of the risks that are in the categories of economic environment, political environment, realistic project demands, the attitude of the government towards the private sector, project's legal and regulation framework, among others. Government risk, on the other hand, is inclusive of contractors' availability, the procurement of bidding, subsidies of the government for the price in avoiding social reaction, the guarantee of the

government against financial risks that cannot be controlled by the private investors, among others. The last group is the project risk, which entails foreign capital, the condition of monopoly for the product or service, construction limits, enough return on investment/equity, maintenance and operation, technical factors, consistency with environmental issues, and others (Yan, 2006).

According to Hailing (2008), risk is classified to six main categories which are: employer generated risk, Contractor Generated Risk, Project Specifications Risk, Procurement Specific risks, Subcontractor/ Supplier risks and External risks. These categories cover a list of 55 risk factors, that are most likely to occur during the construction phase and are likely to cause disputes. Meanwhile, this classification of risk attempt to allocate each event to its corresponding cause. For instance, a common risk cause is the exceeding quantity of Variation Orders or design changes, such risk is allocated to the employer due to the inconsistency of design and the lack of comprehensive design during the tender stage (Hailing, 2008).

Zou et al (2007) in a research on construction risks in china to develop strategies to manage them from the perspective of the stakeholders, classified the risk in a different approach based on the project objectives. Zou et al (2007) identified five main objectives which are the cost of the project, the project duration, the need to obtain the required quality, the environmental objectives and the safety issues that might arise. This classification enables the project management to focus on the project goals and handle the risk events that might hinder their ability to achieve these goals.

Other researchers have classified the risks in several different ways, Gohar (2012) identified the 6 diverse categories. However, he emphasized the contractual risks and financial risk. contractual risks in the authors perception covered the contractual responsibilities, the project deadline and the project duration clauses, the guarantees and payment for losses. While the financial segment focused on the project funding, risks to material costs and investments (Gohar, 2012). Meanwhile, to a large extinct the construction risks identified and studied by several researchers in literature are similar in nature despite their diverse classification. Table 3, reveals the risk events identified from literature:

Table 3: Risk Allocation Perception From Literature review

	Construction Risk Factors	A	B	C	D	E	F	G	Frequency
employer related risks	Late giving of possession from employer	*		*				*	3
	employers take over the site and deny access to main contractor	*							1
	Delay interim payment from employer	*	*	*	*	*	*		6
	Late release of retention money to main Contractor	*					*		2
	Delay in Obtaining Permits and ordinance			*	*	*			3
	Unrealistic contract Duration					*	*	*	3
Consultant related risks	Change of site condition			*		*	*	*	4
	Difference in change order evaluation	*		*				*	3
	Design errors			*	*	*			3
	Excessive quantity variations	*		*	*	*	*	*	6
	Double meaning in specifications		*		*			*	3
	Discrepancies in contract document				*	*	*	*	4
	Reluctant to check for constructability		*						1
	Late information delivery to request for information	*	*				*		3
	Over design and underestimating the costs						*		1
	Incompleteness of drawings and specifications		*		*				2
	Design and specification oversights and errors or omissions resulting from uncoordinated design		*		*	*	*	*	5
	Inadequate site investigation report	*			*			*	3
	The assessment of liquidated and ascertained damages against main contractor	*							1
	Lack of understanding and agreement in contract procurement						*	*	2
	Difference in Actual Quantities of work			*	*	*			3
	Incomplete design				*	*			2
	Design complexity				*	*	*	*	4
	replacement of consultant					*			1
	Shortage of Approved Construction Drawings					*	*		2
Contractor related Risk	01. Inadequate contractor's management			*		*		*	3
	Failure to plan and execute the changes of work	*	*			*			3
	Failure to understand and correctly bid or price of the work		*		*		*	*	4
	Inadequate critical path method (CPM) scheduling and update requirements (poor planning of work)		*		*	*			3
	Architect/engineer dissatisfaction on the work progress of main contractor	*	*			*		*	4
	Main contractor fails to proceed in a competent manner	*		*			*		3

	Non-payment to sub-contractor by main contractor	*							1
	Main contractor ceases work on site	*							1
	Argument on the time extension costs claimed by main Contractor	*	*	*					3
	Main contractor denies access of the site for the sub-contractor	*							1
	Subcontractor works delay due to main contractor	*		*			*		3
	Inadequate tracing mechanisms for request of information	*							1
	Inadequate Quality of work by Main Contractor			*	*	*			3
	Use of Defective Material			*		*	*	*	4
	Main Contractor Labor Disputes.			*	*	*			3
	Labor, Equipment and Material Availability			*	*	*	*	*	5
	Indemnification and hold harmless			*					1
	Improper Budgeting and contingencies					*	*	*	3
	Delay in Mobilization					*			1
External Causes	Consequences of opening for inspection		*						1
	Both parties want to control over proceedings	*							1
	Changes in Governmental regulations			*	*	*	*		4
	Delay or suspension of works								
	Failure to agree on compensation for Acts of God			*	*	*			3
	The absence of team spirit among the participants		*			*			2
	Both parties are not interested to settle	*							1
	Parties have unrealistic expectations	*							1
	No leadership within the project teams	*							1
	Both parties not prepared for negotiations	*							1
	Argument on acceleration cost	*							1
	Poor communication amongst the members of the team		*			*			2
	Failure to respond in timely manner		*						1
	Argument on the prolongation costs	*							1
	Type Of procurement and Variability of bids							*	1
	No trust between the parties and felt no trust on mediator	*							1
	Financial issues of any party (Cash Shortage or Funding Risk)			*		*	*	*	4
	Delay works due to utility services organization	*		*	*				3
	People interruptions				*			*	2
	Inflation in Material and labor cost			*	*		*		3
	Currency and Interest rate fluctuation				*	*		*	3
	Force Majeure				*	*	*	*	4
	Permits and license					*	*	*	3

Note: A = Cheung, Sai On, and Kenneth T.w. Yiu (2007), B = Jaffar, N., et al (2011), C = Loosemore, M., and C. S. Mccarthy (2008), D = Ayasudha, K., & Vidivelli (2015), E = Khodeir, Laila Mohamed et al (2015), F = Abdulaziz M. Jarkas, Theodore C. Haupt, (2015), G = N.N. Hlaing, D. Singh, R.L.K et al (2008).

Meanwhile, the risks that are contract-related do not solely originate from the contract terms itself, but also in how these contracts are handled by the companies. Therefore, respective sources of risk must be included into the processes of risk management. The risks here can be grouped into contract management risk, and contract initiation and negotiation. These are the risks that might arise from the way a party handles the contract, and it could be caused by a misunderstanding of the expectations and roles or ignorance. If a party fails to understand clearly what is required by the contract, the contract handling risks are increased.

Subsequently, the functions of the contract as: control, co-ordination, and adaptation, in order to be achieved the contract clauses need to clear and unambiguous to avoid multiple interpretations of the contract wording, contract drafters continuously attempt to tighten up the contract wording and add more provision in which they have encountered disputes (Hartman, 1997). Hartman (1997) conducted a survey to study how the contracting parties interpret the contract clauses differently, the research then modified the contract wording, and it was observed that by using more accurate wording the contracting parties were able to identify the contract risk allocation and to a large extinct they could arrive at a common understanding.

In a study conducted by Yu Maemura, (2018) in Vietnam, to investigate the main contractual conflicts that affect the project duration, by examining the disputes that arose in several projects. The progression of contractual conflicts and their root causes were identified. From this it was noted that one of the main root causes of conflict in two projects was inadequate contract clarification during the pre-contract period. The case study presented the construction of a road and tunnel in Ho Chi Minh (HCM) City, in which several disputes arose. Meanwhile, the contractor claimed that during the pre-contract stage he found himself in an unfair bargaining position, with the employer trying to reduce the contract price. The contractor during negotiations attempted to clarify the payments terms and conditions, while the employer assured the contractor that strict compliance with the FIDIC provisions will be followed. Unfortunately, this agreement was not clearly documented in the contract, and with the deviated employer's behavior this agreement was not implemented leading to several disputes in payment procedure. A similar case appeared in the

construction of an Expressway near Ho Chi Minh City were the pre-contract negotiations and clarifications were conducted in half a day and lacked thorough review of the contract terms and conditions (Yu Maemura, 2018).

Wenqian et al (2018) have conducted several interviews with experts in the field of contracts management to identify the main contract provision, the research classified the contract provisions based on their function. Similarly, El Hoteiby (2017), conducted a research by analyzing several construction contracts and analyzing the terms and conditions of them. The purpose of the research was to identify the common contract provision that impose the highest risk during the project duration. While the research concluded with a list of main contract provisions that should be clarified and during the pre-contract stage and indicated in the contract agreement to avoid disputes. Table 4 compiles the main contract clauses that were highlighted by El Hoteiby (2017), Wenqian et al (2018), Haapio and Siedel (2013) & Shou Qing et al (1999) that should be clearly identified in the contract and are subject to multiple interpretations.

Table 4: Main Contract Clauses that address risk events.

List of Common Clauses that addressees the risk events Identified:
Scope and Goals
Performance Security & Advance Payment Bond
Program of Works/revised Program
Contract Price and its relation to Customs, Taxes etc.
Adjustments for Changes in Legislation
Adjustments for Changes in Cost
Language and Law
Priority of documents
Communications and reporting
Responsibilities of the parties
Audits/benchmarking
Assignment/transfer
Health, safety, and environment
Delivery/acceptance
Variations
Extension of time for completion
Payment certificates & Late Payments
Insurance/ Warranty
Confidentiality Agreement
Force majeure
Subcontractors
Taking Over
Liquidated Damages
Limitation of liability

Termination
Dispute resolution/ Arbitration

2.2.5 Contract Management and its Processes

As Kahler (2013) explains, contract management has become a major phenomenon of business. Particularly, transnational organizations are increasingly professionalizing the negotiation, implementation, termination, and reviewing of contracts through the use of standardized processes that are grounded on information technology. There are numerous aspects of contract management, it does not have any uniform procedure. The primary features are the contractual electronic documentation and the major events in the life cycle of a contract. They are inclusive of the implementation, conclusion, and agreements review, and the maturity of the claims. Kahler (2013) traces the rise of contract management to at least four factors.

The first factor is the sheer number of agreements that make standardized and central management a necessity. The companies that have numerous clients find it impossible to individually monitor, negotiate, and implement all contracts. This leads to these companies with a lot of vendors or clients to extensively use a contract management system that is computerized. The second factor that has contributed to the rise of contract management is the increasing complexity and length of contracts. A contract might have hundreds of paragraphs, especially in the sector of construction. This makes it increasingly hard for a company to refer to the hard copies. The companies therefore see it necessary to use electronic versions that could be easily searched and that show clearly the links if the clauses that were agreed upon.

Additionally, the vague content of the contracts fuels the need of a standardized contract management. This is more evident in the areas that are experiencing fast developments such as the software industry, making it almost always impossible to understand in advance the exact actions required to attain the goals of the contract. During the lifetime of a contract, the best practices and demands in a particular industry might change, and this makes the parties to frequently abstain from explaining all the details of the promised services and goods. As a result, the details might be fully left out of the contract or described vaguely. The last factor that fueled the need for a system of contract management. As organizations grow, keeping an overview of all contracts that exist becomes increasingly hard. The solution to this is a contract management system that makes the retrieval of the information easy globally (Kahler, 2013).

According to Haapio and Siedel (2013), the process of contract risk management covers various principal steps, and these steps include: (i) risk recognition – threats (potential sources of contract risk) are identified, as well as their causes and consequences, (ii) review of risk – prioritizing and estimating the risks based on their impact and potential likelihood, and (iii) response to risk – response to the risks deemed as most important. Contract management is a process that has four steps that are applicable to any stage of the lifecycle of a contract, and these are:

The first step is becoming contractually literate, which is understanding the legal and business dimensions of a contract, as well as the impact of a contract on successful outcomes of a business, and the related risks. The next step is recognition of contract opportunities and risks. This step requires the identification of sources of opportunity and risk, the causes, and potential consequences. However, one must first determine the business objectives and legal objectives, which are the contractual goals. The third step is reviewing the risks and opportunities of a contract, where one analyzes the risks and opportunities to understand their nature and prioritizing them through determining their magnitude or level or significance. The fourth step is responding to contract opportunities and risks, which is also referred to as risk treatment or risk response (Haapio and Siedel, 2013).

According to Haapio and Siedel (2013), this is where actions and options of addressing the risks and opportunities that rank the highest and controls are put in place to reduce or remove threats. The available options are accepting or retaining the risk, reducing the likelihood of the risk happening, reducing the consequences of the risk, avoiding the risk, and transferring or sharing the risk. The existing standards of risk management are mostly confusing as risk management and the process of risk management have various definitions to various standards organizations and professional bodies.

To conclude, the process of contract evaluation is critical to be able to detect any issues in contract drafting. Hartman (1997) in an attempt to reduce misunderstandings that might occur as a result of the wrong contract wording, recommended that the unclear contract clauses are to be discussed between the parties, in an effort to reach a 'true meeting of the minds.' Modifications can be done where necessary, in addition to effectively allocating risk. Many contractors might lack enough time to go through a lengthy agreement to determine and put into consideration the implications behind every provision. The contract evaluation process heavily relies on the

experience of the management in construction in an attempt to tighten up the contract terms for issues they faced before. Although, there are a few studies that focused on analyzing contract documents and validating the results using surveys or interviews to identify the list of legal and contractual terms that needs to be modified. In addition, the contracting parties nowadays tend to employ engineers and managers to administer the contract process. This raises the need to demonstrate the contract information in a more straightforward and innovative way, which can help better understand the contract during pre-contract stage.

This section concluded with a list of the construction risk factors that needs to be addressed within the contract terms and conditions, along with the common clauses that contractors should carefully assess before signing a new contract. The following sections discusses the contract evaluation methods, their importance and how innovative techniques can be used to present contract terms.

2.3 - Visualization as a Tool of Contract Evaluation

This section aims at exploring the use of radar charts as a contract evaluation technique. It explores the visualization concepts and how they are implemented, as well as the benefits. It shall also give details on how visualization improves the contract readability and the evaluation of contracts (Jones & Oswald, 2001). Contract visualization constitutes adding charts, tables, graphs and images for supplementing the text that could be used to clarify certain contract conditions or compare the different projects and contracts. It offers new and interactive ways of communicating contracts and improving their usability and clarity hence, making the terms and conditions of a contract clear for all contracting parties thus parties can now focus on delivering their obligations rather than trying to resolve disputes (IACCM, 2016). Radar charts on the other hand, are graphical methods of multivariate data display with a two-dimensional chart that has at least three variables that are represented on axes with the same point of origin. They are also referred to as web charts, spider charts etc (Nowicki & Merenstein, 2016)

2.3.1 The Importance of Contract Visualization

Contract visualizations is defined as “explanatory diagrams, charts and systems of icons, juxtaposed to textual clauses in contract documents” (Passera et al. 2016). The term contract documents as used here incorporates both signed and draft formal agreement versions that could

include parts like several appendices and general agreements (Passera et al. 2016). Visualization, in general, can be defined as data representation in visual forms like diagrams, charts, infographics, and maps. The main goals of visualization are facilitating further data analysis and communicating effectively with the audience. Through the use of different visual representations of information, a researcher is able to present a lot of data in quick, clear, and cohesive ways. Thus, revealing the risks and obligation stated in the contract allows the reader to discover with ease the general patterns, exceptions, and outliers from the presented information.

According to Haapio & Passera (2017), contracts are not styled to support readers who are busy and cognitively overloaded when it comes to search, integration, and understand the contained information. The content in the contracts is written while considering litigation, instead of day-to-day support of the business. For a contract to be successful, it can no longer be created by lawyers for lawyers. The contract drafting process as suggested by Haapio & Passera (2017), should be replaced by the concept of interactive contract design. In the contract design concept, strategic choices on goals and drivers of collaboration are merged with legal and business knowledge on maximizing the probability of success and minimizing disputes and risks. This concept is centered on people communications in ensuring that the contract could be successfully implemented within the set time, the allocated resources, and within the budget. Designing a contract is not just a matter of choosing the correct content, clauses, or words. It also entails ensuring that what is written is understood, and that is why the use of visual communication is proposed as a way of enhancing the clarity of a contract. Additionally, more than 90 per cent of companies primarily see contracts as control and compliance instruments instead of business enablers and tools for improving understanding and communication (Haapio & Passera, 2017). Every year, negotiators tend to continue focusing on the terms of dealing with the failure consequences and ignore the most important terms to guide the relationship. These are some of the reasons that make it a necessity to bring in visualizations to make the contract language easy to be understood by all parties involved.

2.3.2 Benefits of Implementing Visualization in Contracts

Passera et al. (2016) carried out an inductive case study with the aim of knowing more about a real-life practice of contract visualizations with the sales team at “CartaFirm” that operates in the paper industry. One of the authors worked with the sales team in integrating icons and

diagrams into the maintenance and operation outsourcing contract. The main goal was to improve coordination, evaluation, and shorten negotiations. It was discovered that the participants viewed visualizations as tools for disambiguating information, signal investment in the developing relationship, and imposing a primitive and positive frame on the contract interpretation of the customers. The need for framing and clarification strategies was to minimize uncertainty, a factor that would hinder relational and coordination mechanisms between the involved parties (Passera et al. 2016). It was also identified during the case study that visualizations were used for reducing the uncertainty that could arise from three contracting process knowledge gaps, and these gaps are cross-professional, inter-firm, and between the phases of contracting.

The number one ingredient of success and coordination that underlies every construction project is communication. Contracts are no different: the contracting processes also have communicative aspects that are just as important. Passera et al. (2016) state that researchers have developed an interest in both the communicative and psychological contract dimensions. Contracts are systems of information processing, and therefore, they influence the gathering of knowledge in organizational relationships, and also the processing, interpretation, and the acting upon of the organizational knowledge (Barton et al. 2013). Clear contract communication has the ability to enhance the performance of a business and also prevent the misunderstandings that could happen between the parties involved (Passera et al. 2016). In addition, communication can facilitate the coordination between parties. The nature of relationships and transactions is shaped by the various clauses and how they are framed, and clarification of expectations and roles (Argyres & Mayer, 2007; Ryall & Sampson, 2009).

During the drafting process, several contract visualization techniques can be used directly to evaluate the contract terms and conditions. Additionally, visualization can also form a separate document about a contract to assist all the parties taking part in the planning, reviewing, or approving the contract, or in implementing or monitoring the contractual terms. Whether alongside a contract or inside it, it is important to note that this evaluation technique displaces the written contract language priority. What these graphics do is that they simply illustrate the actions or words in the contract (Passera et al. 2016). However, they can speed up negotiations and help the contractor to find the needed information faster and could also be used as a reference guide during the agreement implementation. Additionally, visualization could also increase transparency,

inspire trust, and participatory during the process of contracting (Weber et al., 2011; Weber & Mayer 2011).

Visualization can emphasis the significance of a contract function as tool of coordination and communication, while this has been stressed by numerous proactive contracting scholars (Passera et al. 2016). A good contract must help in the success of the parties as well as preventing the legal troubles that could arise. However, there are various requirements for a contract to fulfil these expectations. The contract has to be communicated in a simple and clear way that would allow managers to understand, monitor, and implement the contractual promises. The arising need for clarity is what has driven the researchers to come up with the suggestion of complementing the texts of a contract with explanatory visualizations to reduce complexity (Bakshi et al. 2016; Hatch & Cunlife, 2012). These explanatory visualizations help to evaluate the contracts easily and faster. The graphical evaluation of the documents and the contracting process in well-thought ways has the ability to transform a contract from a traditional legal instrument for risk-shifting or rent-seeking towards being devices for facilitating better innovation, collaboration, strategic planning, relation-building, and social value. Using visualization could also bring an improvement in communication amongst those working through and with the contracts. Stronger communication contributes to the ease of use of the contract.

Experimental studies have also shown that visualizations increase contract engagement and comprehension with documents; however, these experimental studies are yet to explore contract visualization as a real-life coordination and communication practice (Berger-Walliser et al., 2011; Berger-Walliser et al., forthcoming; Conboy, 2014; Jones and Oswald, 2001; Passera and Haapio, 2011).

In an organizational setting visualization can aid coordination, collaboration, and sharing of knowledge according to Passera et al. (2016). On conceptualizing visualizations as boundary objects, that is, artifacts supporting translation and coordination amongst various domains of knowledge, because they can be used flexibly, interpreted, and contextualized in various ways by various actors, all these while keeping a ‘robust’ ordinary meaning that is required in coordinating different actors. Visualizations also have boundary-bridging power that in some cases reside in their ability to clearly encode the relationships and interdependencies between parts and wholes or either a process, a group, or a product. Representations could also be vital in cross-disciplinary

work that requires various perspective to come together into a common outcome (Passera et al. 2016).

2.3.3 Implemented Visual Evaluation Techniques

Several researchers have attempted to utilize different visualization techniques in risk analysis and in contract evaluation. Generally, the approaches discussed in literature have been diverse in terms of visual techniques, basic assumptions and the goals needed to achieve. Some of this research includes graphical user interface (Mahler, 2013), visual representation for deal making (Plewe, 2013), contract visualization (Passera & Happio, 2011) and contract comics, the audio visualization and the multi-sensorization of law (Brunschwig, 2018). In addition, there is a new approach to introduce artificial intelligence as shown below in the process of contract evaluation to further enhance the process and reduce the amount of time spent in analyzing the contract documents.

According to Happio and Passero (2011) the visual techniques utilized are classified to three categories:

- Visual organization and structuring patterns,
- Multimodal document patterns
- Visual representation patterns.

The first category is the visual organization and structuring pattern, this is concerned with the organization and structure of the text to ensure the information are easily readable, and understandable. Some of the most influencing researches in this field are Typography for lawyers (Butterisk, 2015) and (waller et al, 2012) who discussed extensively how the typography can help in clarifying the contract agreement. The second category is the multimodal documents patterns, while this attempts to revolutionize the concept of contract as purely textual document. They tend to introduce more graphical diagrams that incorporate visuals and texts. For example, comics-based contracts (Brunschwig, 2018) in which comics present a series of consequential panels demonstrating several combinations of speech bubbles, signs diagrams to express the content of the contract. An example of this is the book “Bound by Law” which provides a comical representation to the introduction of US copyright Law (Brunschwig, 2018).

The concept of "Contract Comics" have been introduced to discuss the contract design and contract visualization. Its purpose is to assist in the interpretation of the contract wording and ensure that there is no underlying text that can override the visual representation. Such comics can include several scenarios and issues with methods to avoid them (Brunschwig, 2018). For instance, many construction contracts include a provision for dispute resolution, a visual graphic can be used to illustrate a conflict between the parties and demonstrate through the use of several scenarios with bubble speeches, the contractual approach that a party should utilize in order to avoid a breach of contract. Such comics are of great assistance in defining the roles and responsibilities, demonstrating the communication means, presenting the schedule of the project and the contingency plans & in decisions, and controlling rights (Brunschwig, 2018). Another approach would be to incorporate visual contract guide within the contract documents. Such guide constitutes of explanatory diagrams that are used to express the meaning of the contract clauses.

The last category is the visual representation patterns, while these are used to demonstrate statistical information of a common nature in a contract. Such patterns can be represented using table, timelines, flow charts, swim lanes, companion icons & delivery icons. For example, a timeline can be used to illustrate the procedures to submit a claim, showing the date of arise of the event and the allowed duration for the contractor to submit a claim and the duration for the Employer/Engineer to take a decision. While histograms can be used to show the required value of works across the contract duration (Passera & Happio, 2011).

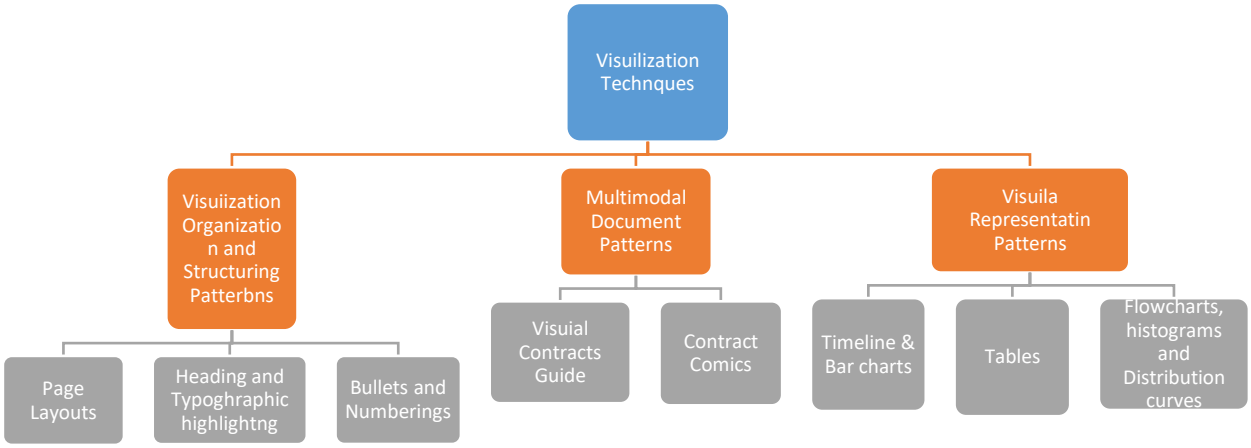


Figure 2: Classification of visualization techniques

Accordingly, the challenges that arise in construction projects such as limitations of time and cost, scope ambiguity, physical constraints, communication difficulties, and a multitude of stakeholders. These challenges impact the projects' success directly while making them harder to manage. These issues have made the construction project teams come up with various techniques and tools that they utilize to deal with these problems. Some of the methods used in visualization of risk are table checklist criticality analysis, event tree analysis, reliability block diagrams & cognitive maps. In addition to these techniques building information modelling (BIM) can enable the early detection of risk, which offers a fast and easier understanding of certain information (Erol et al. 2018). In a case study by Erol et al. (2018) on the visualization of complexity and risk in mega construction projects, the authors aimed at enabling mega project practitioners to understand the behavior of risk propagation in complex environments for improvement in risk communication and making proactive managerial decisions. The case study presented a conceptual framework that represents the interactions between the project complexity and their risk related factors along with the effect on the project performance. Such illustration is based on identifying the complexity actors in a project and any relations between them. Then stating the risk events that could occur and link it to the corresponding complexity factor. This network can reveal the consequences of each complexity factor for better decision making.

Artificial Intelligence is now being introduced in contract evaluation process. Several online platforms have such as LawGEEX (www.lawgeex.com), have arose to provide a faster and accurate review and evaluation to some types of contracts. However, there is still a lack of such systems in the constructions industry. LawGEEX, is built in with several contract review guidelines and the client can insert his own evaluation guidelines. Followed by uploading the contract documents. And the result is a fully reviewed and highlighted contract agreement that emphasis the critical issues and suggests modifications for further negotiation, without having to spend a significant amount of time or money on attorneys in reviewing these documents. Such platforms provide a solution for companies with tremendous number of contracts such as sales and procurement contracts or contracts with a standard review process.

Hence, contracts evaluation of complex mega projects does not only require the project teams to acquire the relevant information of the project, but also to have proper evaluation means for better decision making (Erol et al. 2018). The mode of acquiring the relevant information, or

the preference of the decision-makers on how to evaluate the information, might fail to yield an effective way of information presentation (Lumineau et al., 2011; Flyvbjerg, 2006; Yin, 2014). Although visualization as an evaluation method has numerous benefits in particular areas of project management, it is scarcely used. While, when it comes to the discussion on the application of technology trends for construction industry linear programming techniques as well as statistical diagrams (radar charts) can be applied (Zhou et al. 2013).

2.3.4 Applications of Radar Charts in Evaluation:

The radar chart methodology comes as an alternative solution to traditional measures on managing the activities of a company. Radar charts are particularly a good option during the comparisons of quality data, as there are numerous attributes that could be compared easily, with each being on its own axis. The overall variations are indicated by the shape and size of the polygons (Nowicki & Merenstein, 2016). Radar chart is one of the most effective techniques when it comes to comparing the performance of a single item to the standard performance or the performance of a group.

Zhou et al. (2013) in their research, use radar charts in discussing the technology trends presented in literature which are applied in the field of construction safety. They first note, the technology application frequency in the management of construction safety. In an attempt to depict the trends in a clearer and convenient manner, they divide the time span into periods that have equal years. This information is then presented on a radar chart to depict, "trends of technology application for construction safety," and another diagram to demonstrate the "Trend of research topics of construction safety" (Zhou et al. 2013). In their discussion, the authors contributed to understanding the trends of

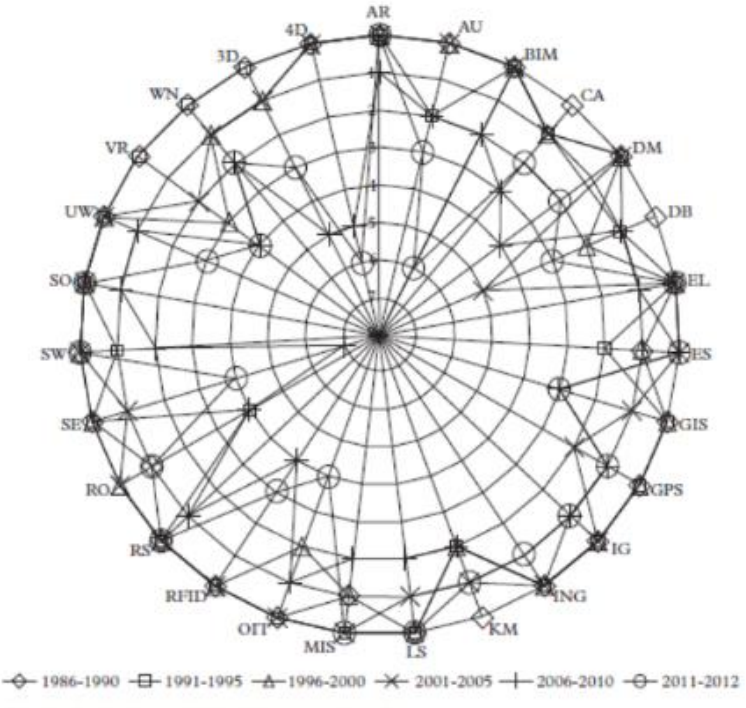


Figure 3: Utilization of radar charts to analyse technology trends in construction extracted from Zhou et al. (2013)

research and utilizing the application of technology for construction safety in a better way. The study illustrates the importance of using radar charts as a technique of evaluation during the presentation of information to make the viewer understand the content more easily (Zhou et al. 2013). Similarly, contracts are all about presenting the views of one party to another in seeking an agreement to certain terms, while one of the best ways to ensure that the other party understands the contents clearly can be through radar charts.

Angel & Benedito (2014) analyzed the management risk and aimed to justify the financial position of companies in Switzerland by using the accounting methodology of radar chart in full. The managers ought to understand the risks that could occur to make decisions that will help the company in achieving its aims. The monetary authority had a primary aim of obtaining the indicators used in measuring the financial market risk and improving the financial report information through modifying the method accounting to the economic entity (Angel & Benedito, 2014). The radar charts accounting methodology is used to obtain these indicators, and the result of these charts are independent, normalized, and objective. These indicators are used in the application of theories sine and cosine of plane geometry on radar charts. These theories are related to a company's financial situation as the average maturation periods are on every axis radial.

Angel & Benedito (2014) adds that the application of the independent, normalized, and objective radar ratios on prospective analysis could yield a more positive analyses than the traditional means that rely on subjective variables. Consequently, the radar chart methodology is helpful during financial crisis as it allows room for the generation of objective, normalized and independent indicators for measuring the management in every area that is represented on a radar chart (Benedito & Angel, 2014).

The radar chart approach was also applied by Chaudhary & Vrat (2017) in their case study that aimed at analyzing the management of e-waste systems in Switzerland, India, Germany, and Japan. The methodology was helpful in assessing the performance of multifunctional systems by comparing the e-wastes management systems performances based on seven main indicators on a five-point scale. The seven indicators are located on top of each axis and illustrate the essential characters of e-waste management. Whereas the five-point scale are used to rank each management system on a scale of 1 to 5, (1 being very ineffective and 5 being very effective). Hence, it is easy to compare the e-waste management system of the four countries in one diagram. Subsequently, in order to compare the overall management systems of every country, a formula was used to calculate the area of each polygon. Comparing the areas of the countries helped in concluding that Switzerland had the best E-waste management systems. However, the radar chart assumes that the number of fields of each criterion is the same and have the same weight.

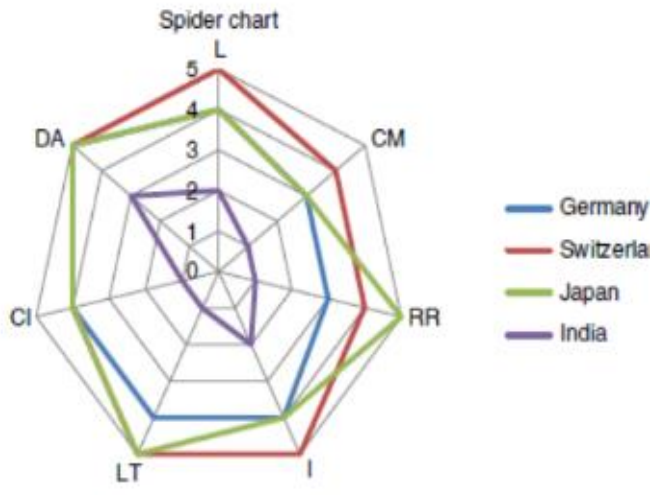


Figure 4: radar chart showing country performance on seven different indicators, extracted from Chaudhary & Vrat (2017)

Similarly, Radar charts, when added to miscue analyses, was of great help to teachers as they could easily help the young children coordinate cueing systems with less explanation (Wohlwend, 2012). Just as risk mapping, radar charts aim at improving the understanding of an organization of its appetite and risk profile, improve the risk assessment model of the company, and clarification of the nature of thinking and risk impacts (Bourass et al. 2016). Li et al. (2017) have also used radar charts for easy calculations in transforming the multi-objective problem to be a single objective problem. Lastly, Peng et al. (2019) state that it is of extreme vital significance to design and explore measures that are more comprehensive for the evaluation algorithms. Peng et al. (2019) recommended the radar charts as one of the top popular methodologies for comprehensive performance evaluation because of its intuitive visualization.

On the other hand, comparing results on a radar chart can be a challenge and confusing if there exist various webs on the chart, or when there are too many axes because of too many

variables that crowd the data. However, this challenge can be resolved through reducing the polygons' opacity but layering more and more polygons on top of one another might make it difficult to distinguish the individual polygons and colors. Attempts by the viewers in comparing the values across varying axes can create different issues, even though there are gridlines connecting multiple axes for reference. According to Nowicki & Merenstein (2016), the variables on different axes are most of the times nominally independent, and they could be representing entirely different measuring scales. When there exists a difference in these scales, the comparison of values across the axes may not seem helpful. Every radar chart axis has a common scale, and this means that there is a need to map the range values of every variable to the shared scare in a varying way. However, this mapping can be misleading, as it is not always clear. The positioning of the axes around the circle can greatly influence the shape and area of the polygons.

In conclusion, evaluation of information or data in visual forms such as diagrams, charts, infographics, and maps, can further facilitate the data analysis as well as establishing effective communication with the audience. To researchers, evaluation is of vital importance, while as the contracting world is undergoing numerous changes, and these changes have been partly because of technology changes, thus innovative evaluation techniques are highly required. People still take contracts as documents that could be used in case of legal matters between the involved parties, other than a document that can be used in clarifying or explaining a certain idea extensively. The use of visual evaluation techniques to make the contracts easier to understand and comprehend is important in making sure that every party involved understands the risks imposed. Visualization techniques supplement the text as written in the contract. One of the techniques of visual evaluation that is widely used is the radar charts technique. Radar charts are simply a graphical methods of multivariate data display that have a two-dimensional chart and with at least three qualitative variables that are represented on axes that originate from a similar point. Other names used in referring to radar charts are web charts, spider charts, start plots, radial chart and polar charts. They can be applied to any information that can be researched. Finally, and based on the above discussion, radar charts shall be used in this research as one of the contract evaluation techniques and will further be developed to be able to quantify the risk for certain contract terms.

CHAPTER 3: METHODOLOGY:

3.1 introduction:

This chapter presents the research design and methodology used in this study. The chapter first reviews the focus of the study which is the Lump sum contracts and briefly discusses the risk allocation and the characteristics of this type of contract that makes it the emphasis of the research. Furthermore, this chapter presents the research design demonstrating how grounded theory is applied in this research using qualitative and quantitative approaches. The chapter also discusses the contract selection criteria and sample size that was implemented in selecting the projects and concludes with presenting the developed checklist for analysis and its classification.

3.2 Research Scope: Lump Sum Contracts:

This research is focused on lump sum contracts. The term 'lump sum' has become widely used in the construction field which usually entails completing the whole of the works as required by the contract documents for a fixed amount within a certain period (Norwati, 2009). Yet, the interpretation of the term Lump sum has experienced several meanings due to the lack of a specific definition. Lots of researchers and standard contract forms have attempted to define the term "Lump sum", which is still sometimes misunderstood, and the correct risk identification & allocation between contracting parties becomes unclear. According to Chow Kok Fong (2004), lump sum contracts may not incorporate a bill of quantities as part of the contract documents, therefore the contractor is deemed to have studied the contract drawings and set a price for the execution of works. The contractor undertakes the responsibility of understanding the project deliverables and to compute the quantities of work from the drawings and included it in the lump sum price (Chow Kok Fong ,2004). Similarly, the Egyptian civil law article no. 658 (1), defines lump sum contract as a fixed fee contract for the agreed design, while no addition or omission to the fees shall be approved unless due to a fault in the design supplied by the employer. Furthermore article 658 (3) of the Egyptian civil law states, the contractor may not request an increase in fees for the increased labor cost or raw materials or other expenses even if this increase makes the execution of the contract onerous (Egyptian Civil Law, 1948).

Several researchers have stated that the most common contract type utilized in construction is the lump sum contracts (Norwati, 2009). In design build projects where the scope of the work can be clearly defined at the early stages, lump sum contracts is widely implemented and accounts for 50.5% of the design build project (Chen Q Et. al, 2016). Furthermore, Chen Q mentioned in his study that the contracting method depends on the project type, i.e., for industrial projects with lots of complexities, a Guaranteed Maximum Price contracts appears to be more favorable as it is difficult for a contractor to determine a price during the tender stage. While, for common civil and Infrastructure projects the Lump sum contracts appears to be utilized in 69.6% of the projects similarly, for commercial projects 57.8% of the projects utilize lump sum contracts (Chen Q Et. al, 2016). Therefore, as the contract type is usually selected by the owners and is drafted by them, employers tend to be more inclined to implement lump sum contracts as it ensures the project completion without additional cost.

Several risks arise during the project, while these risks should be allocated to their respective parties. The risk allocation in lump sum contracts is unique making it the scope of this research. The contract being a tool that should identify the project risks and distribute it between the contracting parties. According to Sweet (1992), a good contract clearly notifies the parties with their obligations and rights, it attempts to anticipate the likely problems and implements a procedure that properly allocates the risk. Similarly, Chan, Et al. (2011) stated that the construction risks should be allocated to the party who is best capable at handling this risk with the least cost. Therefore, Risk should not be allocated to the party who can bear the consequences if the risk occurs. While, if a risk is distributed over several parties, this distribution should reflect their ability to influence the likelihood of the occurrence and the effect of the risk. Finally, risks which are out of the contractor's influence should by default be assigned to the employer. Considering these criteria, contract types such as Unit price contracts and cost-plus contracts tend to experience a more balanced risk allocation between the contractor and the Employer (Chan, Et al, 2011).

Meanwhile, in Lump Sum contracts, employers tend to transfer most of the risk to the contractors without considering the optimal risk distribution. The most significant of these is the risk of quantities, which becomes the contractor's role to recalculate the quantities that will be executed on site during the tendering stage to set a reasonable pricing. Contractors would probably integrate a higher risk contingencies mark-up in their bids to compensate for all these risks. The contract being a fixed price, and the profit being inversely proportional to the cost, cultivates the contractor's incentive to try to reduce cost even if it risks the quality or the safety. Besides, the contractor's main goal to reduce the project schedule as it usually leads to less indirect cost and hence more profit (Goudarzi, 2016: Mesfin, 2014: Zaghloul, 2006). Figure 5 demonstrates the various contract types and the associated risk allocation of the contractor vs the employer for each contract type, it shows that lump sum contracts and guaranteed maximum price contracts tend to enforce most of the risks on the Contractor.

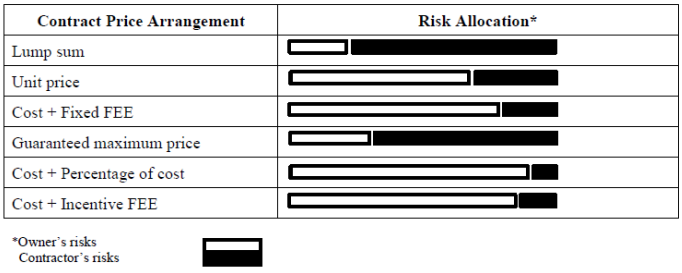


Figure 5: Risk Allocation in Contracts. Extracted from Goudarzi, 2016

Lump sum contracts have several distinct characteristics that separate them from any type of contract where they transfer almost all the burden to the contractor. It also puts a cap on the overall price and have unique characteristics when dealing with variations etc. (Abed, 2015). Some of these characteristics are:

1) **Lump sum Tender:** in which the contractor during tendering stage quotes a fixed price for the execution of works according to the drawings and specifications. However, disputes might arise because of a missing item from the drawings that the contractor failed to include in its price during the tendering stage which is necessary for the project to be fit for its purpose (Norwati, 2009). The evaluation of such items is detailed below.

2) **Lump sum contract documents**: in essence, the lump sum contracts are to complete the whole of the works for a fixed sum of money which becomes due to the contractor after complete performance have concluded. Therefore, the main contract documents that are needed to ensure complete performance are the drawings and specifications. A schedule of rates may be included in order to regulate the amount to be

added or deducted from the lump sum in case of any variations solely. Unless otherwise stated in the contract conditions, no alteration shall be made to the contract value as a result of any deviations in the quantities of works stated. unlike re-measured contracts, no detailed measurements are required to be submitted except for the evaluation of variations that are instructed by the employer (Norwati, 2009).

Meanwhile, the obligation to complete the works fit for its purpose is not extinguished if the indispensable works are not specified, or not clearly shown in the drawings, or wrongly calculated. Thus, the contractor is expected to study the employer's requirements and account for any missing item in the pricing, as there shall be no additional consideration if during the course of the project the contractor discovered any discrepancies.

Some contract conditions define the hierarchy of documents to avoid discrepancies and assist the contractor during the tending stage. The hierarchy of documents guides the contractor to which document to abide by to resolve contradictions between the drawings and the specification etc. Whereas, the presence of this hierarchy is not essential, some employers may opt to state that all contract documents are mutually explanatory, while any discrepancies or contradictions between the documents shall be resolved by the engineer without extra cost. Hence, the contractor during the tendering stage is required to price the project according to the most stringent option for any issue involving discrepancies to avoid losses (Norwati, 2009).

3) **Lump Sum Contracts denotes Substantial Completion:** under the Egyptian Civil Law article no. 203 (1), specific performance is required as along as it is possible. While article 654 specifies that a lump sum contract shall be terminated only if the performance becomes impossible (Egyptian Civil Law, 1948). With that said, as long as the contractor is capable to complete the works, the contractor is obliged to deliver the project fit for its purpose to the employer, regardless of any claims or disputes that may arise during the course of the project. Similarly, the employer is not entitled to avoid payment due to minor issues that does not hinder nor affect the use of the project. The employer can only request these rectifications to be done. Hence, substantial completion does not mean the perfect execution of works (Norwati, 2009).

4) **Valuation of variations:** lump sum contracts may include a provision that allow the employer or the engineer to instruct the contractor to carry on modifications that were not included in the scope or to omit parts of the works. This emphasis the purpose of the bill of quantities in lump sum contracts which is to assist in the evaluation of variations in case of any additions or omissions from the contractor's scope.

However, in some cases the variations requested might not be mentioned in the bill of quantities or might not be indicated in the drawings and the employer decided to omit them, this may lead to disputes if the parties did not agree on a methodology to evaluate such variations. Table 5 below presents some of the most common variation scenarios that occur in lump sum contracts which are likely to cause disputes over their evaluation:

Table 5: Evaluation of Variations in Lump-Sum Contracts

Case No.	Variation Scenarios:	Evaluation of variation:
1	• Items in drawings and/or specification • Priced in the BOQ • Employer decided to partially delete the scope.	In case of Partial omission, if there is a unit rate, the quantity to be deleted is calculated from the tender drawings then multiplied by the unit price. Else if the work is stated as a lump sum amount then the omitted scope is calculated as a percentage of the total amount indicated in the drawings and the same percentage is deducted from the Lump sum amount.
2	• Work NOT specified in drawings and/or specification. • Priced in the BOQ • Employer deleted them from the Scope.	If the corresponding item is not present in the drawings or specification, then price omission is not feasible as the contract price is fixed for delivering the project fir for purpose, and if the project requirements are the same then there is no omission.
3	• Works or items in drawings and/or specification • Not priced in the BOQ • Employer deleted them from the Scope. (totally or partially)	Where work items are not priced in the BOQ but there are works items on the drawings and specifications then it is a Contractor's risk and responsibility to deliver the works. If the Employer decided to deduct these works partially or fully from the contractor's scope, then he

		may deduct what the Contractor should have priced and included during the tendering stage. The deduction in the Contract Price should be calculated on the net difference between what is required compared to what the Contractor should have priced for.
4	• items in drawings and/or specification • Not priced in the BOQ • Employer decided to Substitute these products or materials.	If there is a substitution of products or materials which are not in the BOQ, then, the Contractor may only be entitled to recover difference in the two products or materials.

Finally, if contracts lack a provision for variations, this makes the contractor liable to execute the works as stated in the contract and as indicated in the drawings and specifications only. While any variations that will be requested along the course of the project shall require modifications to the contract itself or to establish a new contract. The party entitled to issue variations should be clearly stated in the contract to enable the contractor to recover any additional costs incurred because of carrying out additional works.

Accordingly, lump sum contracts are vastly used in construction projects and are becoming increasingly used in Egypt during the ongoing economic and political conditions as they provide a safeguard for employers to ensure completing the project within the budget allocated. In addition, lump-sum contracts possess a unique risk allocation bearing most of the risks on the contractors, hence it is crucial for contractors to comprehend these contractual risks prior entering into an agreement. Furthermore, the rigorous risk allocation in lump sum contracts on the contractor and the unique characteristics of this type of contract can lead to several disputes if the contractor did not carefully consider them.

3.3 Research Design:

The purpose of this research is to develop the contract evaluation procedures to analyze the lump sum contracts in Egypt against a set of critical terms and conditions to better understand the contract, and to do so creating a database for the most common lump sum terms and conditions

implemented by employers in Egypt is required. The database shall act as a datum line for contractors to compare new contracts terms and conditions with it, while contractors will be able to identify if a critical contract condition is missing or if a contract condition imposes a significant risk factor on the contractor. In addition to, understanding and measuring the risk balance incorporated with every group of contracts conditions & evaluate the performance of the entire contract. The outcome of this research is an innovative evaluation method that utilizes all the gathered database from the collected contracts and utilizes mathematical models and linear programming techniques to identify the risky terms and conditions for a new contract. Furthermore, it presents a method to analyze several contract terms and conditions that are grouped together and calculate the contract balance index (CBI) for each group of conditions. To achieve this purpose of this research Qualitative and Quantitative approaches were implemented to gather and analyze the contract terms and conditions as demonstrated below. Data envelope analysis technique is further implemented to evaluate the entire contract without relying on approaches such as surveys and interviews etc. that may lead to subjective results.

3.3.1 Qualitative Research:

Qualitative approach has been used in several researches in the last four decades (Stanslaus, 2011) especially in researches related to contract terms and conditions, analyses of contract wording (Hartman & Snelgrove, 1997) and in identifying the common contract condition (El Hoteiby, 2017). This approach is effective in analyzing words, reports, or conducting a study in a normal setting. Qualitative approach employs several methods of data collection to gather and analyze aspects of subjective nature. This includes the grounded theory which incorporates collection of documents, applying a coding system, and generating a theory, and analyzing observations. Case studies are also used in this approach as an instrument to understand the purpose of an issue and to respond to questions in the form of "Why" and "How" (Stanslaus, 2011: Thomson, 2010). Similarly, in a research conducted by Hassanein (2007), case studies were employed to identify the risk factors that affect projects in Egypt, in which two construction projects where chosen, all the documents were gathered and analyzed, from this it observed the main issues that arose during the course of the projects that helped in defining the main risk events.

In this research qualitative approach was first implemented in gathering and creating a list of contract terms and conditions from literature that are most likely to cause disputes if not

identified in the contract, in addition to identifying the main contractual risk stated in literature that are most significant throughout the project stages and addressing these in the contract terms. This stage concludes with a preliminary list of terms and conditions that are then converted to a list of question, as indicated in appendix A to be fulfilled in the next stage.

The second stage involves gathering 18 lump sum contracts for private sector construction projects conducted in Egypt. For each project, all General and any Particular conditions are studied, and the required information is extracted and stated against the list of terms and conditions. While any missing contract terms are identified during this stage and highlighted. Throughout the contracts review stage, constant adaptation to the preliminary list of terms and conditions is conducted based on the revealed contracts information's:

A) Terms and conditions that appear to be against the Egyptian law or does not comply with the rules and regulations of Egypt are eliminated.
B) Terms and conditions that contradicts the lump sum contracts characteristics or does not apply to this type of contracts are eliminated.
C) Contract terms and conditions that address risk events specific to the nature of construction in Egypt are added to the list.
D) For Terms that are descriptive and rely on the wording of the contract, the different wording variations are gathered to be analyzed in next stages.

Thirdly, as this research is targeted to improve the contractors understanding of the contract terms, the all the contract terms and conditions gathered are analyzed from the contractor's perspective to identify the most favorable conditions for a contractor and the worst conditions for a contractor to have in a contract. With this information, contractors can negotiate the least favorable contract terms to try to balance the contract risk allocation.

The results are then compared against the Egyptian Civil Code and against one of the most common standard contract forms that is widely implemented in Egypt, the FIDIC standard conditions (Red book), although this standard contract is used for re-measured contracts, it is observed that it is vastly used in projects in Egypt, with some modifications in the particular conditions to make it suitable for lumpsum contracts. El Hotieby (2017) in his investigation about the common conditions in Egypt, it was observed that 61% of the analyzed contracts had FIDIC as the standard contract conditions. Therefore, the FIDIC 1999 Red-Book conditions are used in

this research as a validation tool against the created list of terms and conditions and comparing the results with the gathered & analyzed contract terms and conditions.

3.3.2 Quantitative Research:

This approach has been used by scientist in most of the research as it relies on the use of measurements and numerical analysis to test a theory and identify if a hypothesis is valid or not while the results produced can be generalized (Stanslaus, 2011). To consider aspects of a subjective nature experiments and surveys are the most common techniques used, with a constant set of categories and one or two variables are left to monitor their behavior. Most of the research focused on identifying the risk factors in construction tend to rely on surveys directed to experts in the field to state what are the major risks they faced or utilize surveys in trying to signify the importance and magnitude of several risk events, such as N. Hlaing et al, (2008) Perceptions of Singapore construction contractors on construction risk identification, Shen L. Y (2001) Risk assessment for construction joint ventures in China, Chan D. et al (2011) Risk ranking and analysis in target cost contracts: Empirical evidence from the construction industry, Abd Karim, N. A et al (2012) Significant risk factors in construction projects: Contractor's perception & Zou, P. X (2007) Understanding the key risks in construction projects in China. However, the results of the surveys may be inaccurate if the respondent filling the survey is providing false statements or did not comprehend the question or the question is leading the respondent to a certain result. Thus, this research opted to focus on a statistical analysis of the data gathered rather than the interpretations of other to reveal a more accurate and precise analyses of the contract utilized (Goddard & Villanova, 2006)

In this research the data obtained from the gathered contracts were analyzed using the Statistical Package for Social Scientist (SPSS). The data collected are of three types, Numerical, Binary and terms. firstly, the Numerical criteria, such as the percentage of advance payment & performance bond stated in a contract, the percentage of allowed variations, and the duration to receive the interim payments. For these numerical results statistical analyses were conducted to identify the distribution and standard deviation of the set of values gathered. Secondly, the binary set of data are used to define items that or of yes or no type, or true or false, such as the presence of Liquidated damages, or does the contract allow Arbitration, for this set of criteria, the statistical analyses were conducted to identify the frequency of occurrence of each result etc. Finally, the last

set of data is composed of descriptive contract terms that can have different wording variations, the different forms of this term are gathered and inserted in the tool as a drop-down option. The wording of these items is analyzed to identify which is more stringent and places more risk on the contractor against the more favorable option to the contractor.

Subsequently, the second technique implemented is the computation of radar charts, which relies on calculating the area of the radar chart through this following equation:

Assume there are n values v1,…,vnv1,…,vn in your chart.

Let vn+1=v1

The area S of the polygon is the sum of the areas of n triangles whose vertices are the center of the chart and two consecutive vertices of the polygon. Each of them, according to the law of sines, has area:

Equation 1:Area of Triangle

$$S_i = \frac{v_i v_{i+1} \sin\left(\frac{2\pi}{n}\right)}{2}$$

Then you can compute S as following:

Equation 2: area of polygon

$$S = \sum_{i=1}^{n} S_i$$

As each vertex of the radar chart demonstrates a defined contract term which imposes a certain risk on the contractor, thus the area under the radar chart is set to define a risk Balance index (RBI) for this group of terms. Three radar charts and their areas are depicted for each group of terms. The first demonstrates the most favorable conditions for a contractor obtained from all the contracts, the second is most extrinsic conditions on a contractor that impose most of the risk, while the last diagram demonstrates the actual contract conditions defined by the user. From the areas calculated the user can compare the Contract Balance Index between the New contract and the previously analyzed contracts. In addition, a radar chart has been computed for each group of terms for all the previous contracts separately.

A database for these areas was created with each group of the 18 contracts. Users can now understand the Contract balance Index of each group of terms in comparison to all the contracts gathered and with the optimum conditions and the pessimistic conditions.

The last technique used is Data envelope analysis (DEA), while this is one of the linear programming methods which is a data-oriented approach to evaluate the performance of a set of entities called Decision making units (DMUs). Data envelope analysis was first presented by Charnes et al. (1978), it is basically a nonparametric frontier estimation methodology for measuring the relative efficiencies and performance of a collection of related comparable entities (DMUs). Its advantage is that is does not requiring neither cost nor any behavioral assumption in its formulation (Sala-Garrido et al. 2012). The objective of a Data envelope analysis is to assess the efficiency of each DMU in relation to its similar class. The result of a DEA study is a classification of all DMUs as either efficient or inefficient. After identification of efficient DMUs, they can be set as benchmarks for the improvement of other inefficient DMUs (El-Demerdash et al. 2013). The main objective of the present study is to evaluate the relative efficiency of construction contracts based on the 7 identified contract categories and using the DEA technique and to generate strategies for identifying and improving the performance of inefficient ones. This efficiency analysis has been carried out to suggest the possible benchmarking so that the relatively inefficient contracts can be improved.

To implement data envelope analysis to measure the relative efficiency of a Contract, we used a linear programming model to construct a hypothetical composite contract based on the inputs for the 7 categories gathered from the 18 contracts. The methodological framework proposed for the implementation of Data Envelope analysis, consists of six steps (Anderson, 2008):

1. Determine the weights for each operating unit, that can be used to decide the inputs for the composite operating unit.
2. Enforce a constraint that requires the weights to sum to 1.
3. Require the output measure of the composite operating unit to be greater than or equal to the corresponding output for the respective operating unit.
4. Define a decision variable, E, which determines the fraction of the operating unit’s input available to the composite operating unit.

5. For each input measure, write a constraint that requires the input for the composite operating unit to be less than or equal to the inputs available.
6. State the objective function as Max E.

The input measures required to determine the performance of the Contract are the calculated Contract Balance index for each Contract Category, which are derived from the contract terms. Similarly, this technique could also be used to compare the performance of any number of categories in the contract, i.e., each Contractor may opt to determine the important categories from his perspective as demonstrated in Chapter 5 and compare the performance of these alone or determine the performance of the entire contract. Nevertheless, the inputs required to compare the performance of the Contract are:

1. The CBI for Project Scope (PS)
2. The CBI for Financial Model (FM)
3. The CBI for Operations (OP)
4. The CBI for Claims & Variations (CV)
5. The CBI for Extension of Time & Liquidated Damages (EOT)
6. The CBI for Liabilities & Dispute Resolution (LDR)
7. The CBI for Termination & force Majeure (TR)

For each input of the above, the sum of the RBI of each contract is multiplied by its respective weights as demonstrated in the equation below:

Equation 3 = $\sum$ [(PS of C1 ×Weight) + (PS of C2 ×Weight) + (PS of C3 ×Weight) +….(PS of C18 ×Weight)]

Equation 4 = $\sum$ [(FM of C1 ×Weight) + (FM of C2 ×Weight) + (FM of C3 ×Weight) +…. (FM of C18 ×Weight)]

Equation 5 = $\sum$ [(OP of C1 ×Weight) + (OP of C2 ×Weight) + (OP of C3 ×Weight) +…. (OP of C18 ×Weight)]

Equation 6 = $\sum$ [(CV of C1 ×Weight) + (CV of C2 ×Weight) + (CV of C3 ×Weight) +…. (CV of C18 ×Weight)]

Equation 7 = $\sum$ [(EOT of C1 ×Weight) + (EOT of C2 ×Weight) + (EOT of C3 ×Weight) +…. (EOT of C18 ×Weight)]

Equation 8 = $\sum$ [(LDR of C1 ×Weight) + (LDR of C2 ×Weight) + (LDR of C3 ×Weight) +…. (LDR of C18 ×Weight)]

Equation 9 = $\sum$ [(TR of C1 ×Weight) + (TR of C2 ×Weight) + (TR of C3 ×Weight) +…. (TR of C18 ×Weight)]

The DEA approach requires that the sum of these Contracts weights equal 1. Hence, to determine the weight that each contract will have in computing the inputs, we use the following Constrain:

Equation 9: $WC1 + WC2 + WC3 + \ldots\ldots\ldots + WC18 = 1$

The output measure of the DEA model, for the composite contract is a modified CBI value for each of the seven input measures, which is based on multiplying the E value obtained from Solver with the RBI of the composite contract. With a constrain to limit the max value that can be obtained for each category as follows:

For each input: (RBI of Category × E value) ≤ Eq (x)

i.e., For Category1: (RBI of PS × E value) ≤ Eq (3)

This constrain in implemented to ensure that the composite contract output is restricted with the frontier values of the gathered contracts. As the objective function of the E is the max value, which would indicate the most favorable contract conditions to the contractor, there should be a limit imposed. This limit is obtained from the frontier which is derived from the gathered contracts. As more contracts are included in the study, the frontier can be modified dynamically to incorporate the new contract conditions and the new CBI in the contracts.

Finally, The DEA efficiency conclusion is based on the optimal objective function value for E. The decision rule is as follows:

1. If E= 1, the composite contract (Contract in question) incorporates the optimum conditions for the Contractor, that it is located on the frontier of the gathered contracts.
2. If E >1, The composite contract is less efficient, thus the composite contract incorporates more risky provisions on the contracts making it less favorable to the contractor. While the degree of contract improvement that can be achieved is the percentage over the value of 1.

3.4 Sample Size & Contract Selection Criteria:

In this research grounded theory was implemented which dictate the need to generate enough information until the patterns, concepts, or properties of a phenomenon is generated and no new information in released (Thomson, 2010). Hence the determinant of the sample size is to

have no new information emerging and the relationships among categories are well developed while any other samples collected becomes repetitive. According to Morse (2000) the sample size that achieves theoretical saturation depends on the research scope. A broad research scope will require a larger sample to be able to identify the nature of the phenomenon. Thomson (2010) in his research to identify the correct sample size for grounded theory, he reviewed 100 articles that implemented the grounded theory in several disciplines. He discovered that 33% of these used a sample from 20 to 30, while 32% used a sample between 10 to 19 and 22% used more than 31. Whereas the correct sample size can be determined from previous literature related to the same topic.

Similarly, this research builds up on the work conducted by El hotieby (2017), in which he analyzed a sample size of 28 construction contracts in Egypt without focusing on a specific type of contracts, to identify the main contract provision. This research has utilized the identified provision in creating the preliminary list of criteria as demonstrated in the following section. However, El hotieby (2017) criteria of selection for the 28 contracts was to select medium to large scale project, that utilized International standard conditions or ad-hoc contracts albeit of the contract type. Meanwhile this research is focusing on Lump-Sum Contracts solely and has a narrower scope of contract analysis to identify the main contract conditions used in this type of contracts.

Finally, many foreign developers rely on lump sum contracts for their projects. While it was also implemented in several governmental mega projects such as the electricity stations and complex transportation projects. However, during the contracts gathering stage it was observed that some of the contract conditions are repetitive due to the presence of several Ad-hoc contracts from the same developers/ employer who utilize the same contract conditions. Hence, this research has avoided using these contracts once again to avoid getting a biased analysis. Therefore, the sample size that could be gathered from different project types and from various employers in Egypt and after analyzing the gathered contracts were 18 contracts.

The contract selection criteria for this research focused on Lump-sum projects in Egypt, that are either engineering procurement, and construction type of projects (EPC) or design build projects which are the most common project types that utilize lump-sum contracts. In order to have a fair comparison and valid results, this research focused on medium to large scale projects, which are targeted for contractors how are aware of construction management science and utilize these techniques in their evaluation. In addition, medium and large-scale projects usually involve a high contract value which possess a huge risk on the contractors if they are not carefully studied.

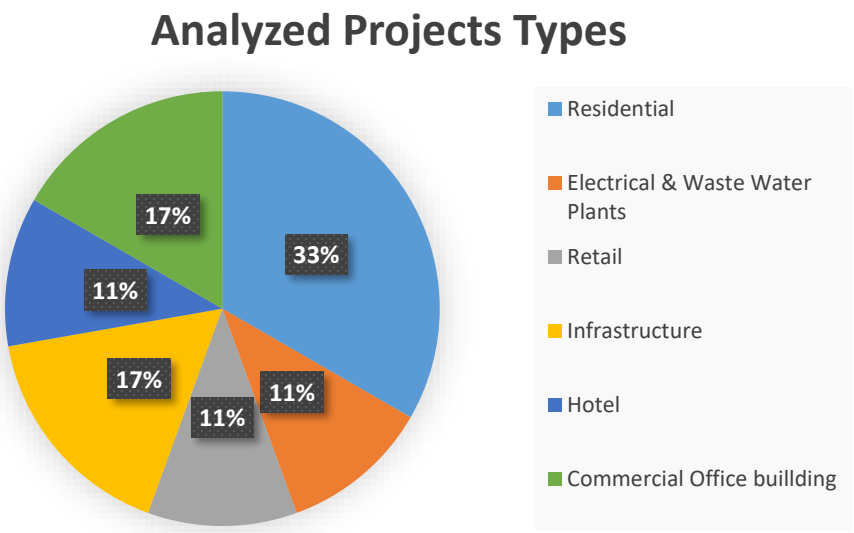


Figure 6: Analysed Project types

The types of projects analyzed are divided to residential, commercial (Malls, office Buildings, Hotels, Hospitals) and industrial and infrastructure projects. Figure 8 shows the distribution of the project analyzed. However, for the sake of confidentiality the names and the parties of the projects shall not be revealed. The majority of the projects analyzed are residential consisting of 33% of the gathered contracts, and this is justified due to minimal complexity of residential projects while the contractors are able during the tendering stage to compute an accurate pricing. This allows the employers to achieve their goal of completing the project with the determined amount. Followed by this, it was observed that commercial office buildings and infrastructure project utilized a lot of lump sum contracts occupying 17% of the gathered contracts each.

Half of the gathered contracts utilized FIDIC standard conditions as part of the contract documents, which complies with the findings of El Hoteiby (2017). While most of these projects utilized FIDIC 1999 Conditions of Contract Construction for Building Engineering as the general contract conditions for these projects being the most common standard form of contract in Egypt, with some modifications in the particular conditions to make it applicable for the Lump sum projects, a fewer number of projects utilized FIDIC 1987 standard conditions with similar approach. Figure 7 shows the percentage of contracts that implemented each of these standards. The remaining half of the projects implemented ad-hoc contract, which complies once again with the findings of El Hoteiby (2017) who indicated that the majority of his gathered contracts utilized ad-hoc contracts which enabled the employers to draft a contract that suites their needs and protects their interest.

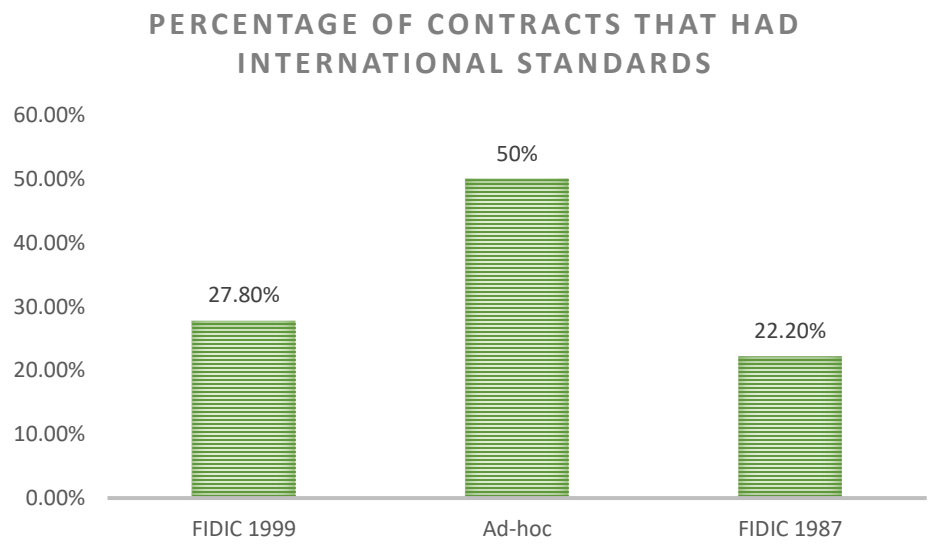


Figure 7: International Standards utilised in gathered contracts

3.5 Classification and Coding of Contract Terms:

After gathering most of the critical contract provisions and the contractual issues addressed in literature in chapter 2 that leads to delays or disputes, and including any special provisions that are related to the lump sum contracts, a preliminary list of critical contract terms compromising of 115 items was compiled, as indicated in Appendix A. The preliminary criteria were in the form of questions to be filled throughout the contract's analysis process. This aided to discover the wording of the contracts terms that are enforced in Lump sum contracts in Egypt.

As far as the classification of the contract terms, this research to ease the contract analyses process and to group the related contract conditions and to calculate the Contract Balance Index in the later stages, where classified to seven main categories which define the contractual issues related to: project scope, Financial Model of the project, Operations, Claims & variations,

Extension of time & Liquidated damages, Dispute resolution and Termination and force majeure. Underneath these seven broad categories are stated 23 sub-headings identified from this research analysis that cover most of the contractual risks and critical provisions in a project, as indicated in figure 8 below:

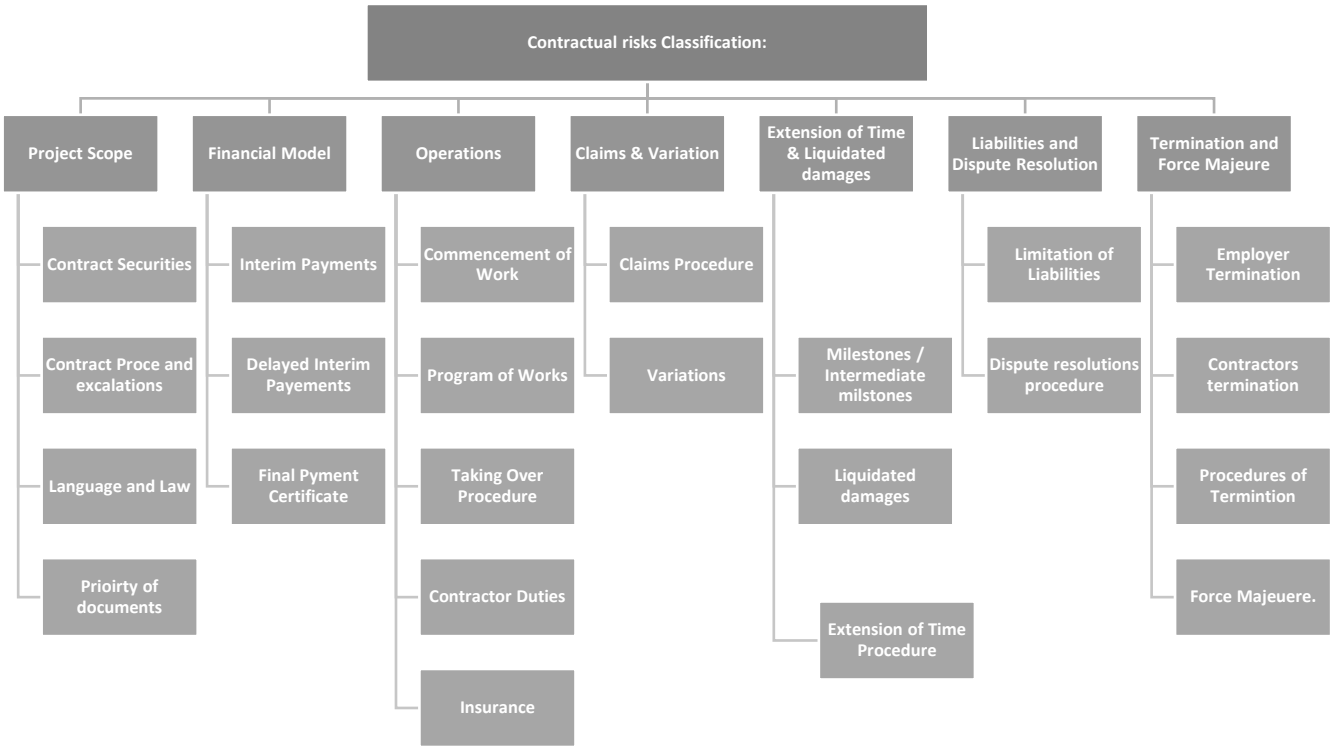


Figure 8: Classification of Contract Terms

Beside each of the conditions mentioned in the list (Appendix A) it is stated the type of answer that is expected, whether numerical, Yes or No, Descriptive, or States a responsible party (Employer, Contractor, Project Manager, or Consultant). This shall unify the contract analyses process, making it either to extract and fill the necessary information. In addition, each of the criteria has a reference number which was added to facilitate the use of this information gathered in the radar chart analysis tool and in creating the database of the common contract provisions.

To summarize, qualitative and quantitative approaches were implemented in this research to gather and analyze the necessary information from the contracts. The scope of the research was narrowed to focus only on lump sum contracts to be able to identify the terms and conditions implemented in them. The concepts of grounded theory as satisfied in the sample size collected

while, the FIDIC 1999 standard contract conditions shall be used to compare the results of the research. The contractual risks were classified to seven main categories and further divided to 23 subcategories to cover most of the contractual risk provisions. Radar chart were then utilized to demonstrate on each axis, the different contract conditions, wordings, or options available for each contract terms and to show the most favorable and least favorable for the contractor. A separate radar chart was created for each of the 7 main categories, and computing the area of the radar chart, helps to identify the Risk Balance Index of this category.

Finally, data envelope analysis is proposed to assess the relative efficiency of construction Contracts. The model was applied to 18 lump sum contracts in Egypt to assess their relative efficiencies in favor of the contractor. Such an analysis helps contractors to identify the degree of efficiency of the contract terms and therefore helps in making critical decisions regarding accepting the project or not, and further helps in highlighting the contractual risks prior to commencing the project. This information can assist the contractor in negotiating better contract conditions or allocating the necessary resources early on to mitigate these risks.

CHAPTER 4: RESULTS & DISCUSSION:

4.1 Introduction:

This chapter displays the results of the gathered contracts and discusses the lump sum terms and conditions implemented in Egypt, in comparison with the findings of El Hoteiby (2017). In addition, it presents the final list of contract provisions that should be included in lump-sum contracts. It also analyses the contract terms statically and demonstrate how this information was used to create a database for calculating the risk Balance index in the tool created. It reviews the risk allocation of the discovered contract terms from the contract perspective and discusses how contractors can rely on the Egyptian Civil code to overcome some of these risks.

4.2 Contract Analysis Results:

This section presents the results, observations, and discussion for all the 18 contracts gathered. The results for each category are presented collectively, in order to be able to understand all the terms and the risks associated with this category rather than isolating and studying each provision on its own. For each category, observations that led to modifications to the preliminary

list of criteria are stated, followed by the statistical analyses for the numerical terms and binary terms.

4.2.1 Category 1: Project scope:

This is the first category of the contract classification implemented in this research. The purpose of this category is to define and analyze the main project information & scope which are usually agreed upon in the form of agreement and that can significantly affect the Contract Price during the project. This section is divided to 4 sub-categories covering twenty different contract terms, related to the contract currency and its escalations, the contract securities required from the contractor with their percentages, the language and laws enforced in the contract and the terms related to the hierarchy of documents if any. These sub-categories defined under project scope were highlighted in five of the top 30 common particular conditions identified in El Hotieby (2017) research.

Observations:

It was observed in all contracts that the rates are fixed throughout the project and the BOQ quantities are estimates and it shall not provide grounds for the contractor to claim for any additional costs if the quantities appear to be higher or lower. Hence, the contractor is deemed to have studied the contract drawings and assigned the price based on this study. It was also noted that all contracts stated the lump sum contract value and indicated that this price is inclusive for all works unless they identified certain elements that will not be included in this value. It was observed that most of the contracts analyzed defined the earthworks and the landscape works as its not included in lump sum price and will be subject to re-measurement, due to the lack of the ability to identify the exact quantities during tendering. This completely adheres with the characteristics of lump sum contracts stated in chapter 3.

It was observed that all lump sum contracts required the contractor to submit a performance bond and that the cost associated with issuing and maintaining the performance bond throughout the project duration and the defects liability period is borne by the contractor, therefore these two terms were removed from the list.

El Hotieby (2017) indicated in his study five provision to be defined for the advance payment, that are covered in this research however it was observed that all contracts clearly stated

that the advance payment decreases with time based on the amortization of the advance payment in the interim payments, hence this item was deleted and replaced with the provisions for amortization of advance payment.

Finally, it was observed that the party responsible for any costs associated in complying with authorities rule & regulation to complete the project is the contractor in all the analyzed contractors hence it was removed from the statistical analyses.

Analyses of Numerical Terms:

As mentioned earlier, the analyses of numerical results were done using SPSS. Table 6 below demonstrates the findings of this analyses while the numerical terms of this category are:

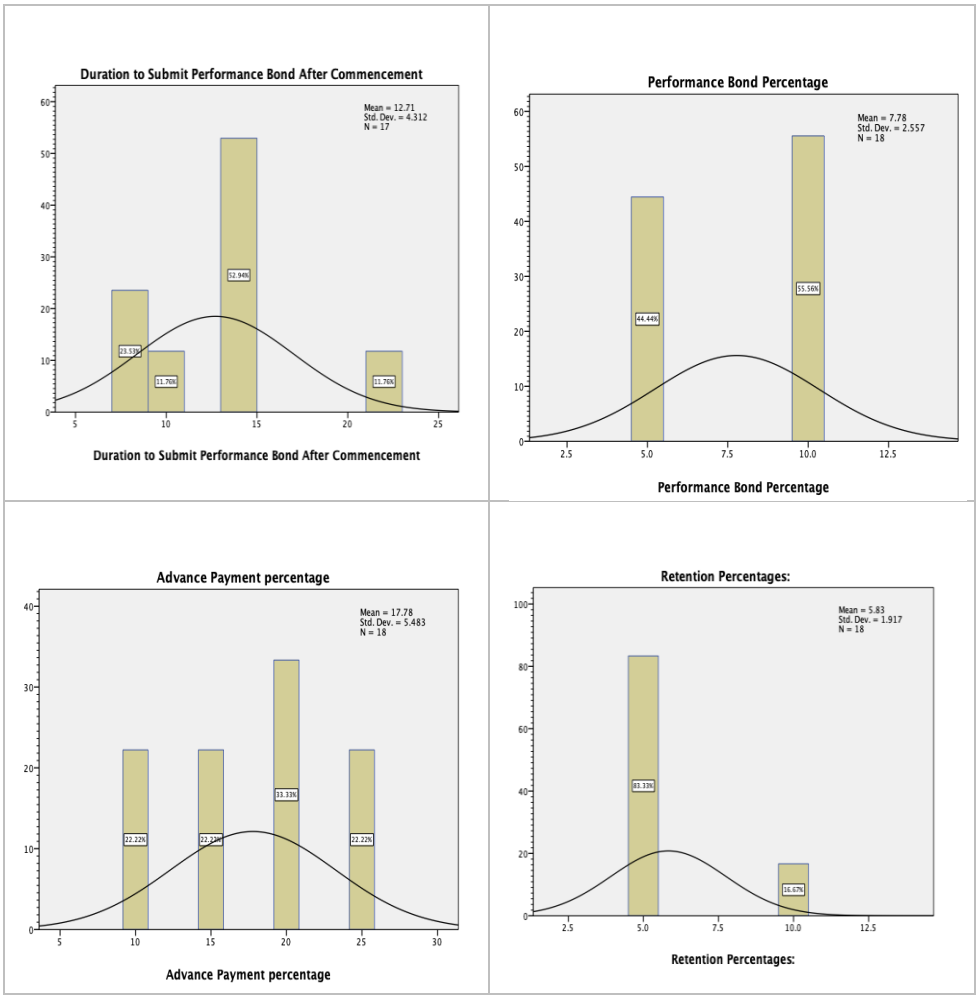
- The duration to Submit Performance Bond After Commencement
- Performance Bond Percentage
- Advance payment percentage.
- Retention Percentages.

Table 6: Numerical results for Project scope

		Duration to Submit Performance Bond After Commencement	Performance Bond Percentage	Advance Payment percentage	Retention Percentages:
N	**Valid**	17	18	18	18
	Missing	1	0	0	0
Mean		**12.71**	**7.78**	**17.78**	**5.83**
Median		14.00	10.00	20.00	5.00
Mode		14	10	20	5
Std. Deviation		**4.312**	**2.557**	**5.483**	**1.917**
Variance		18.596	6.536	30.065	3.676
Skewness		.334	-.244	-.159	1.956
Std. Error of Skewness		.550	.536	.536	.536
Range		14	5	15	5
Minimum		**7**	**5**	**10**	**5**
Maximum		**21**	**10**	**25**	**10**

1) The duration to Submit Performance Bond After Commencement: it was noted for this item that almost all the contracts specified a duration to submit the performance bond, while this duration ranged from 7 days after commencement up to 21 days after the commencement, giving the contractor more time to obtain the necessary bonds.

Table 7: Distribution of results for Project scope



2) Performance Bond Percentage: the value of the performance bond that the employers request in Egypt range between 5 to 10. While the majority requested a value of 10%. Hence, the lower the performance bond value the more favorable it is for the contractor as it will require lower band guarantees and lower costs associated to maintaining these bonds, while having a higher duration to submit the performance bond will be more convenient to the contractor.
3) Advance payment percentage: the most common advance payment percentage implemented in Egypt for the analyzed lump sum contracts was 20 % of the contract value, while the maximum value observed was 25% and the lowest value was 10%. This information can assist contractors during the tendering stage to negotiate a higher advance payment value.

4) Retention Percentage: the majority of the contracts specified the retention value from every interim payment certificate to be 5%, while some required a percentage of 10 percent to be deducted. As shown in the table above.

Analyses of Binary Terms:

The binary terms defined in this category are mainly related to the contract currency, whether the contract implements an escalation formula for the main construction materials and for defining the hierarchy of documents. Table 8 below shows the Pie charts for each of the terms with the frequency of occurrence of each result.

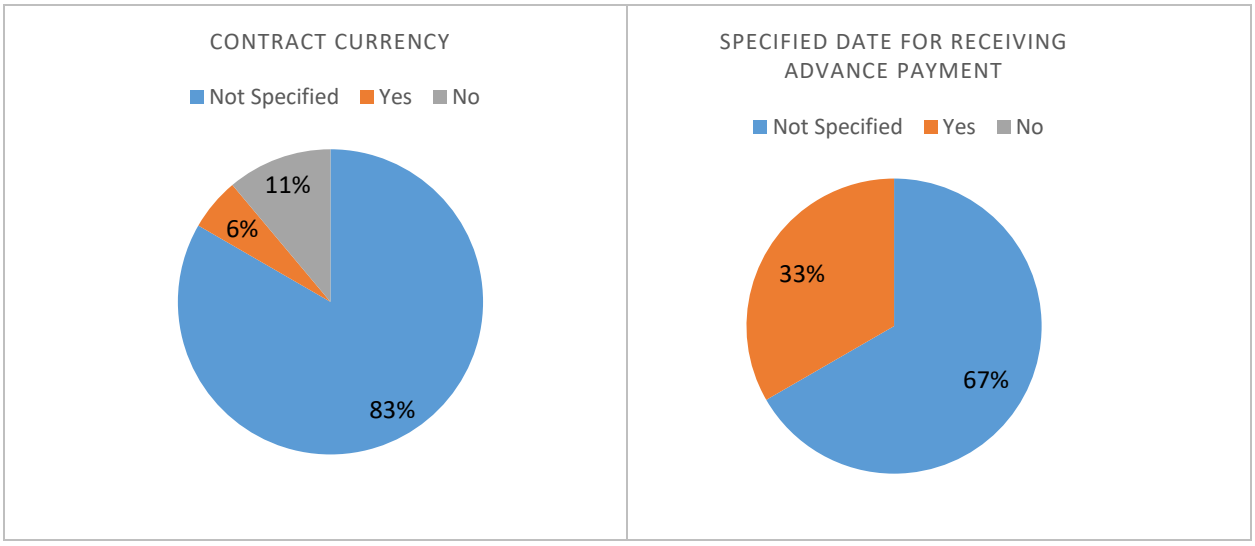
1) The majority of the contracts analyzed were in Egyptian currency. With a few contracts in US Dollar and only one project in Euros. Having the contract currency to be a foreign currency was of a huge advantage during the year of 2016, where the Egyptian currency experienced a devaluation. Furthermore, if there are lots of imported items that constitute a huge amount of the contract value, then a foreign currency could be beneficial to the contractors. However, during the year of 2020, the Egyptian currency has been steady.
2) El Hotieby (2017), in his research mentioned that contract should specify a date for receiving the advance payment, while if the employer is delayed paying the advance payment the Contractor can withhold the works or claim for financing costs. Similarly, it was noted that most of the contracts studied specified that date.
3) It was discovered that only 44% of the contracts analyzed allow escalation of the contract price. Which indicates that more than half of the employers are not willing to re-evaluate the contract price during the project duration. However, from the gathered contracts it was observed that items that had an escalation formula are mainly Steel, Cement, Diesel & Dollars for items that are imported.
4) Changes in Legislation can also affect the contract price, 83% of the analyzed contracts had a provision allowing the contractor to regain any additional costs incurred because of changes in legislation. While 5.56% had a provision stating that there shall be no compensation of any kind and the risk is borne by the contractor and the remaining 11% of the contracts remained silent to this part.

   Meanwhile, the Egyptian Civil Code under Article 147 paragraph 2, allows the contractor to claim for any additional costs incurred as a result of exceptional and unpredictable events

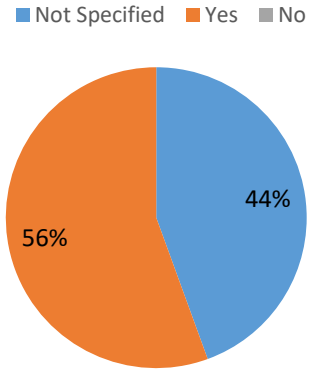
that makes the contractual obligation burdensome in a way to threaten the debtor with excessive loss. This article can be used during negotiations to convince the employer to include such a provision, however in court the contractor must prove that this change has caused significant losses.

5) 95% of the contracts indicated that the costs of complying with the authority's rules and regulation to complete the work is borne by the contractor. Whereas the remaining contracts stated that the employer's obligations is only limited to assisting the contractor in case needed.
6) Half of the contracts gathered incorporated a hierarchy of documents. Stating the higher contract documents, can affect the contract value during tendering stage, in case there is no hierarchy of documents and their exists ambiguities or contradictions, the contractor is expected to price on the most stringent conditions which is inaccurate.
7) Furthermore, only 16% of the contracts had a provision stating that in case of any ambiguities or contradiction in the contract documents and the contractor abided by the hierarchy of documents. If the employer which to enforce any of the other documents the contractor will be entitled to a variation. Whereas the majority of the contracts, lacked such provision or indicated that all the contract documents are mutually explanatory.

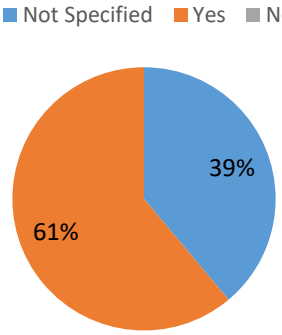
Table 8: Results for Binary Terms in Project Scope.



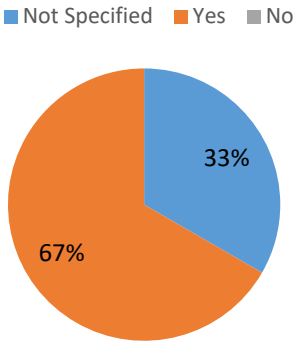
CONTRACT PROVISIONS ALLOWS ESCALATION



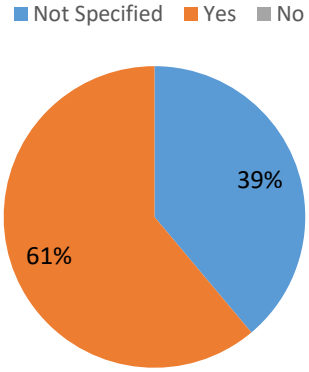
ADJUSTMENT FOR CHANGES IN STEEL:



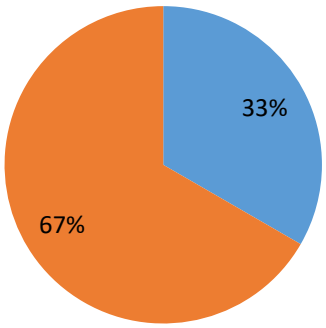
ADJUSTMENT FOR CHANGES IN CEMENT:



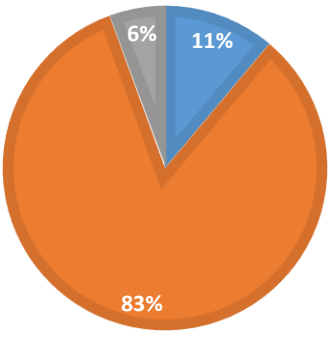
ADJUSTMENT FOR CHANGES IN DIESEL:



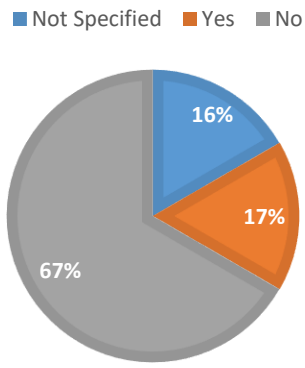
ADJUSTMENT FOR CHANGES IN DOLLAR VALUE:



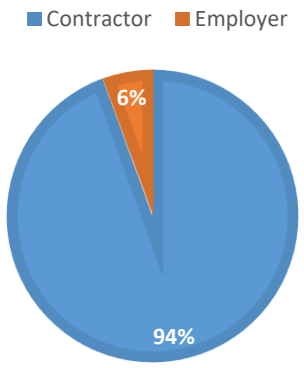
ADJUSTMENT FOR CHANGES IN LEGISLATIONS:



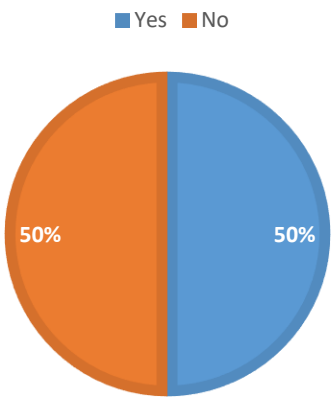
CONTRACTOR ENTITLED TO PROFIT & OVERHEAD IN CASE OF CHANGE IN LEGISLATIONS



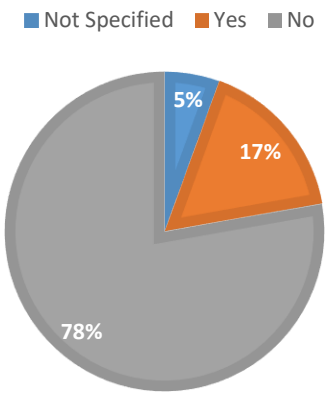
PARTY RESPONSIBLE FOR COSTS ASSOCIATED IN COMPLYING WITH AUTHORITIES & REGULATIONS



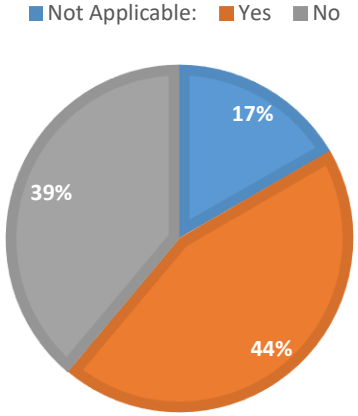
CONTRACT DEFINES HIRARCHY OF DOCUMENTS:



AMBIGUTIES IN DOCUMENTS CONSIDERED VARIATIONS:



HIGHER STANDARD DOCUMENT DEFINED FOR DOCUMENTS WITH SAME PIRIORTY



Analyses of Descriptive Terms:

In this category there was one descriptive item related to the amortization of advance payment. In the contracts analyzed there were Four different options indicated for the employer to regain his advance payment and they are:

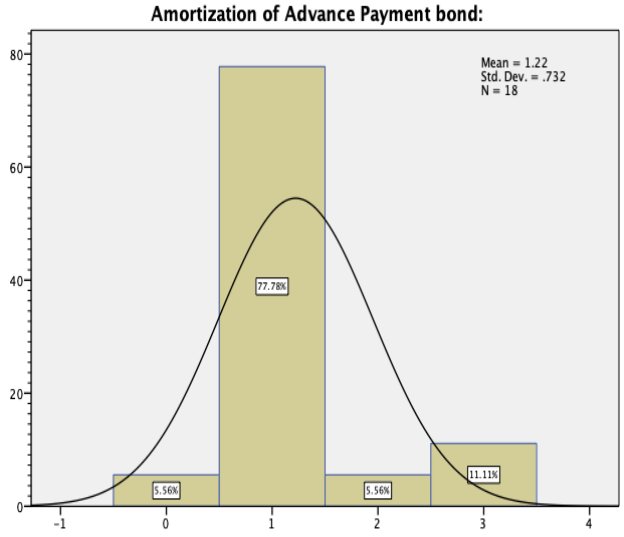


Figure 9: Distribution chart for Amortization of Advance Payments

1) Deducted from each interim payment a specific percentage equal to that of the advance payment.
2) Deduct an amount equivalent to 15% of the advance payment, every time the cumulative value of works reaches this amount. And this was observed in only one contract.
3) Deduct an amount equivalent to 20% from every interim payment although the advance payment was not 20% of the contract value.
4) The last options were the lack of specific of provision that indicate how the advance payment will be retrieved by the employer.

Figure 9 shows the distribution of the four options in the contract. Each option was giving a number to be inserted in SPSS with Zero being the lack of presence of the provision. and one being the most common provision which is the deducting a percentage equal to the advance payment from every interim payment.

4.2.2 Category 2: Financial Model:

This category examines the payment terms in contracts, they focus on three aspects which are the interim payment certificates, the final payment certificate and the procedures and contractors' rights in case of any delayed payments. Such provisions are crucial for a contractor to be able to analyze the cashflow of the project. The category analyses these payment terms using 15 main provisions.

El Hoteiby (2017) in his research indicated that there are five main provisions that should be identified in the contract and they are related to:

- Listing the materials that entitle the contractor for payment upon delivery.
- Stating the information that are required to be included within the interim certificates.
- Defining the consequences of slow rate of progress.
- Indicating the contractor's entitlement to payment for works with non-available rates.

This research has carefully examined these issues during the contract's analyses, and included other terms that specify the durations for the contractor to receive the payments and the maximum review period by the supervision consultant etc.

Observations:

It was observed in all the gathered contracts that there is no provision allowing the contractor to receive payments for works done that does not have a rate in the BOQ, similarly, the contracts did not specify a mechanism for the contractor to receive the payments for items that are indicated in the BOQ and not present in the drawings.

Secondly, the majority of the contracts specified in the general conditions, that one of the main supporting documents for work to be included in the Interim payment certificate is the inspection of works by the Supervision Consultant. However, no provision specified how can the contractor receive partial payments for works not inspected by the Supervision Consultant.

Analyses of Numerical Terms:

In evaluating the financial model and the cashflow of the project, contractors are keen to identify how long will it take to receive their payments for works done. The procedure for Interim Payments approval and issuance of money in medium and large-scale projects usually require the approval of the Supervision Consultant/ Cost Consultant, the Project manager, and the Employer. The summation of these durations allows the contractor to anticipate when he will get paid for the works done. This section has focused on analyzing the duration needed for:

1) Review period by Supervision Consultant: it was noted that only half the contracts had a set duration for the Supervision Consultant to review the interim payment and approve the works done. The minimum duration for the Supervision Consultant was 14 days from the day of submitting the Interim Payment and the Maximum noted duration was 28 days.

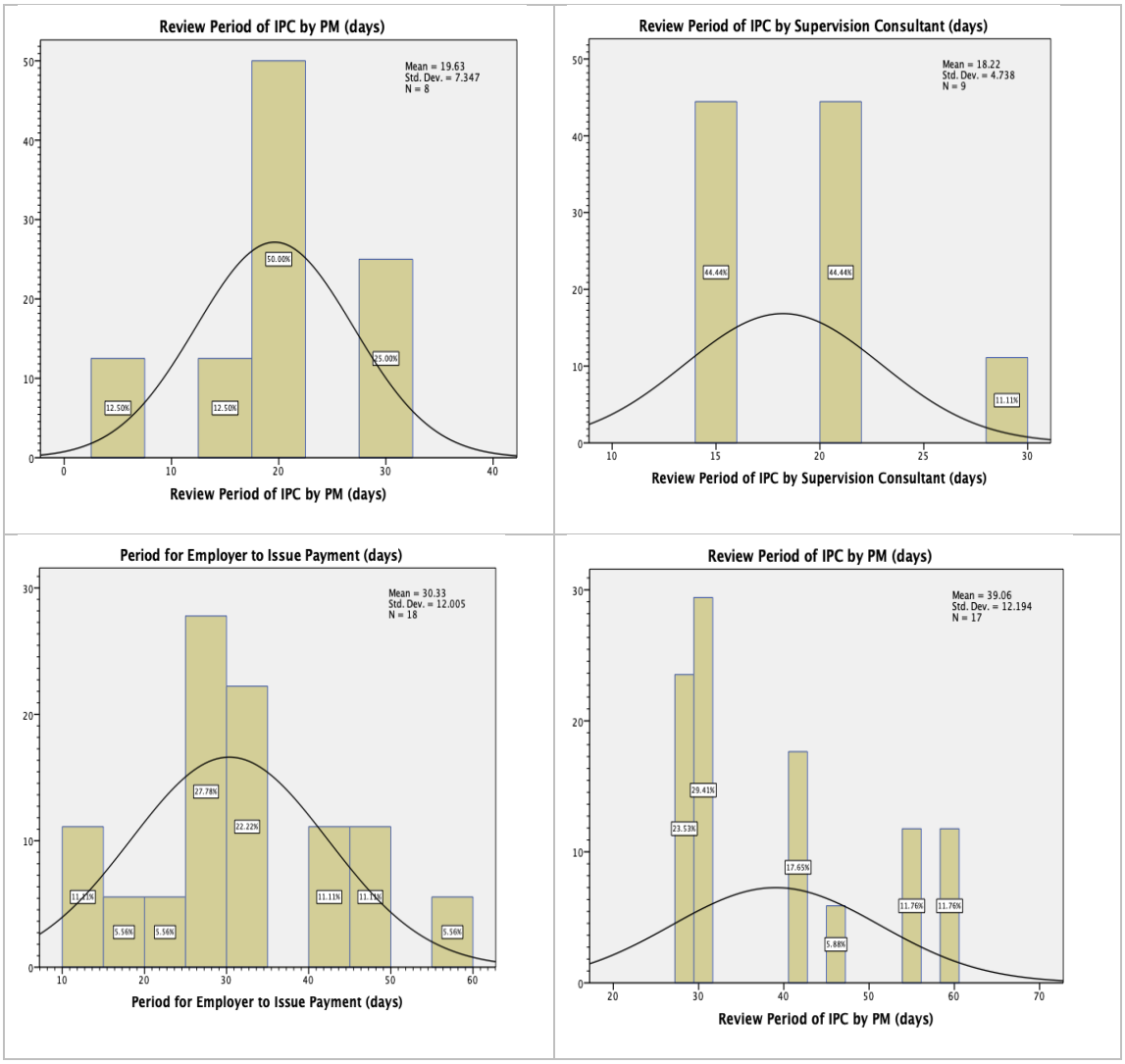
Table 9: Numerical results for Financial Model Provisions

		Review Period of IPC by Supervision Consultant (days)	Review Period of IPC by PM (days)	Period for Employer to Issue Payment (days)	Final Certificate: Review Period of IPC by PM (days)
N	**Valid**	9	8	18	17
	Missing	9	10	0	1
Mean		**18.22**	**19.63**	**30.33**	**39.06**
Median		20.00	20.00	29.00	30.00
Mode		**14[a]**	**20**	**28**	**30**
Std. Deviation		**4.738**	**7.347**	**12.005**	**12.194**
Variance		22.444	53.982	144.118	148.684
Skewness		.992	-.984	.158	.720
Std. Error of Skewness		.717	.752	.536	.550
Range		14	23	45	32
Minimum		**14**	**5**	**10**	**28**
Maximum		**28**	**28**	**55**	**60**

2) The review Period of Project Manager: After the Supervision Consultant reviews the submitted documents & determines the value of works that should be paid to the contractor, the Project manager can re-visit these works and add or deduct monies that are due on the contractor. For instance, if there are safety Violations or deductions, or reimbursement for withheld amounts, they are usually done in this stage. This period usually occupies about 20days as indicated in the distribution chart. However, the duration was examined to go as low as 5 days with a maximum of 28 days.
3) Duration for Employer to Issue Payment: this is the final stage for the contractor to get paid. The lower the overall duration for all the three stages the faster the contractor can receive the interim payments and the better the cashflow of the project. The results for this stage showed a wide distribution and ranged from 10 days to a maximum of 55 days. However, the average of all results was 20 days.

4) Lastly, it was noticed that the review period by the Project Manager for the Final Certificate may vary. However, the review period of the supervision consultant and the duration for the Employer to issue payment are the same. For the majority of the contracts this duration was noted to be 28 days, while in some cases this duration reached 60 days. Thus, the contractor after completing a milestone or the whole of the works might have to wait longer for the final payments to be issued.

Table 10: Results distribution for Financial Model Provisions



The distribution curves in table 10 can help the contractor in evaluating the financial terms and conditions of the project, and in understanding the most common duration implemented in Egypt. Each contractor must consider the addition of these duration to identify how long after the

submission of the interim payment is needed to receive the monies. However other conditions are also necessary to evaluate to understand what is considered in the interim payments and the contractors rights that will be discussed below.

Analyses of Binary Terms:

The binary terms in this category were used to identify if there are provisions that allow the contractor to protect his rights in case there was delayed in payments or in case the Supervision Consultant did not consider lots of works in the Interim Payments.

1) The first condition was whether the contract allow the contractor to object on the issued payments. The presence of such provision provides a mechanism for the contractor to formally object on the Supervision Consultants and the Project Manager's determination and re-evaluate the interim payment to receive the additional amounts, therefore this provision is crucial for the Contractor. However, the results showed that only 22% of the contracts included this provision.
2) During the construction stage, lots of activities may be partially completed or are concluding but will require the Supervision Consultant additional time to inspect and approve the works, while in large scale projects these works can account for millions of dollars and will severely affect the cashflow. Hence, the second condition is related to whether the contractor can receive payments for works done but not yet completed or not inspected by the Supervision Consultant prior to the submission of the interim Payments.

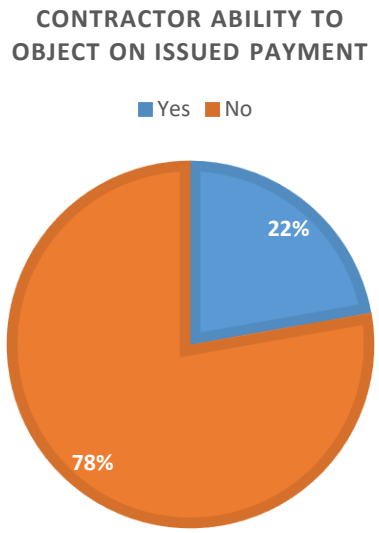


Figure 10: Pie Chart for Contractors ability to object on Payments.

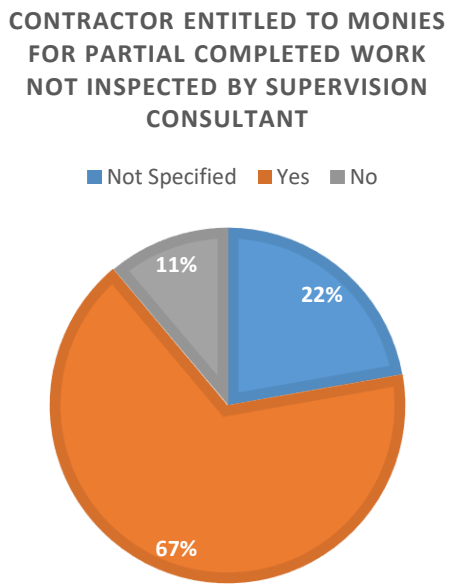


Figure 11: Pie chart demonstrating the Contractor's entitlement to payment for inspected works

This is usually related to whether the contract allow the contractor to submit any documents that indicates that the works are done or allow the supervision consultant the power to release a percentage on account of these works, else the contract only allows payments for works that are inspected. The results showed that almost Two third of the contracts allow the contractor to demonstrate that the works are in progress in any means not just through an approved Work inspection request. While only 11% restricted it to having an approved work inspection request and 22 % did not clarify the documents required.

3) Contractor's right for interest for delayed payments: half of the contracts incorporated a provision to entitle the contractor to receive interests. Meanwhile, it was noted that the interest rate should be equivalent to the Interest rate of the Central Bank of Egypt at the time of the delay.

   Whereas the Egyptian Civil Code under article 226 & 227 entitle the contractor to receive interest for delayed payments even if the contract does not include such provision. However, the Egyptian Civil Code entitles the contractor to receive 5% interest for commercial matters with a maximum of 7%, compared to the Central Bank of Egypt which offers more than 10% as interest rate.

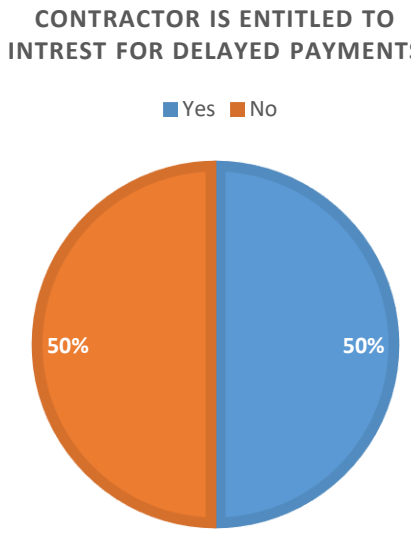


Figure 12: Pie chart for Contractor's entitlement to interest for delayed payments

4) Finally, more than half of the contracts analyzed allowed the contractor to claim for Extension of Time in case of delayed payments. This is beneficial to the contractor as it allows the contractor to reduce the rate of progress and reduces the burden of having to finance more activities in order to meet the deadline.

   While, suspension of work or reducing the rate of progress is a right protected by Law under article 161 of the Egyptian Civil Code, which states "*In bilateral*

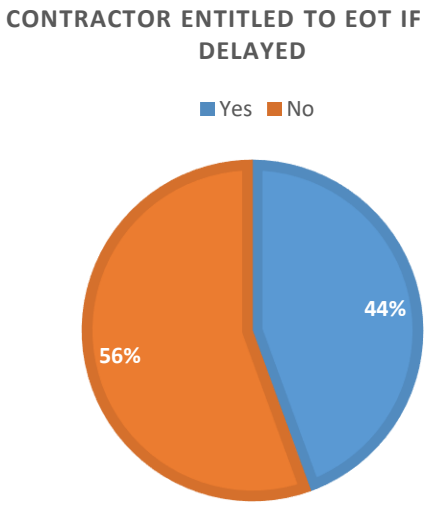


Figure 13: Pie chart for Contractor's entitlement to Extension of time for delayed payments

contracts, when reciprocal obligations are due for performance, either of the contracting parties may refrain from performing his obligation, of the other party does not perform his obligation." Hence, enabling the contractor the ability to apply for an extension of time for delayed payments is a right that should be included in the contract and ensure that a provision for interest payment is included with a percentage equivalent to the Central Bank of Egypt to cover his financing costs during this duration.

Analyses of Descriptive Terms:

To conclude the analyses of a projects financial model and be able to evaluate the cashflow of the project, it was noted that some contracts enforce a condition to enable the contractor to submit the interim payments. Furthermore, for some of the items such as the architecture and MEP work it was noted that there was variance regarding the percentage of payment paid to contractor once the material is delivered on site. The results of these terms are discussed below:

1) Conditions for submission of interim Payments: half of the analyzed contracts incorporated a condition that needs to be achieved by the contractor to be able to receive payments for the works done. This puts the contractor under pressure every interim to achieve this condition. The most common conditions discovered were:

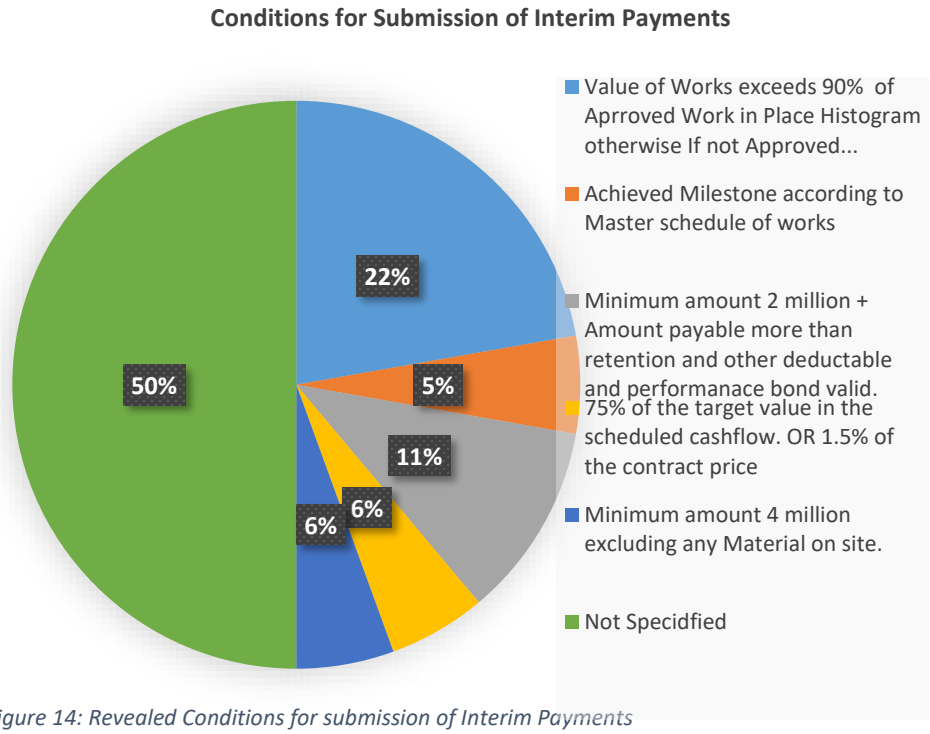


Figure 14: Revealed Conditions for submission of Interim Payments

A. The value of works exceeds 90% of Approved Work in Place Histogram otherwise If not Approved Yet 80% of the preliminary work in Place Histogram.
B. Achieved the milestone according to Master schedule of works.
C. Minimum amount 2 million plus any amounts payable more than retention and other deductible and performance bond valid.
D. 75% of the target value in the scheduled cashflow. Or 1.5% of the contract price for every interim payment
E. Minimum amount 4 million excluding any Material on site.

Option A & D requires the contractor to abide by the histogram incorporated within the contract documents and with a tolerance of 10%. Hence, the contractor must ensure these works are completed and inspected by the Supervision Consultant carefully throughout the interim period to be able to receive payments.

Option B was limited to MEP Design Build Projects, where the Employer has set his requirements and included a list of milestones to be achieved to conclude the project on time and is willing to pay after each milestone is achieved. This requires the contractor to be able to sustain payment for the work and any overheads until the milestone is achieved.

Options C & E, which requires the contractor to complete works equivalent to certain amount of money, ranging from 2 Million to 4 Million Egyptian Pounds, might be considered one of the least risks in medium and large-scale projects with large contract value.

2) Consequences of Failure to submit all supporting documents for Interim Payments: Two third of the contracts analyzed had stated in the contract the Employer's ability to withhold an amount of money in case the contractor did not submit the required documents to review the interim payments as indicated below:

A. Employer to withhold the IPC 100%
B. Employer to withhold 25% of IPC.
C. Employer to withhold 15% of IPC.
D. Engineer to withhold 5% of the payment
E. Engineer to deduct % of the works.

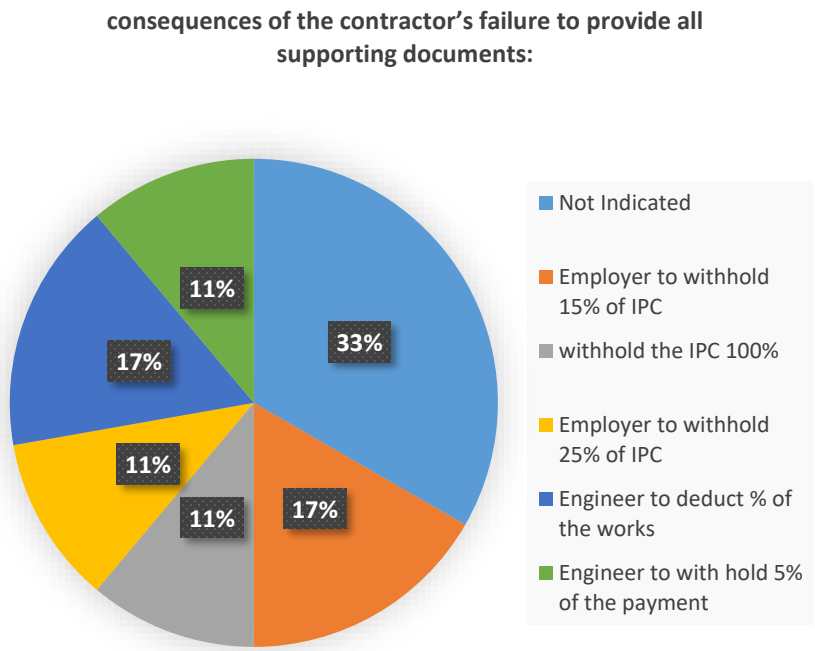


Figure 15:Consequences for failing to submit all interim payment documents.

The most stringent of these is option A, which puts the contractor at risk of not getting any payments if the supervision consultant could not review the interim payment. While options B, C & D, entitle the contractor to receive a portion of the Interim Payment and the rest to be released after submitting the required documents. Option E allows the Engineer, as the party reviewing the Interim Payment to deduct a percentage of the payment if he considers the documents missing, without restricting this capability until the Contractor can prove these works are done.

Thus, the contractor can analyze from his perspective and depending on the type of the project whether these conditions are tolerable or impose a significant amount of risk. The lack of such restriction relives the contractor from the need to ensure that the Supervision Consultant have received the all the documents he requested.

3) Percentage of Monies due for on Site Material and Architecture and MEP works: In lots of contracts the contractor is entitled to partial payment upon delivery of the materials on site. Such provision was included in more 75% of the contracts and is used to supports the contractors cashflow. For instance, some projects allow partial payment for the contractor upon delivery of the steel elements, as the contractor may purchase them in bulk for the entire project and will require a period of time to conclude these works to be included in the Interim Payments. It was noted that there are three options stated in the contracts analyzed and they are:

A. Contractor entitled to 75% of the Material Invoice.
B. Contractor entitled to 70% of the Material Invoice.
C. The Percentages are agreed upon in the contract.

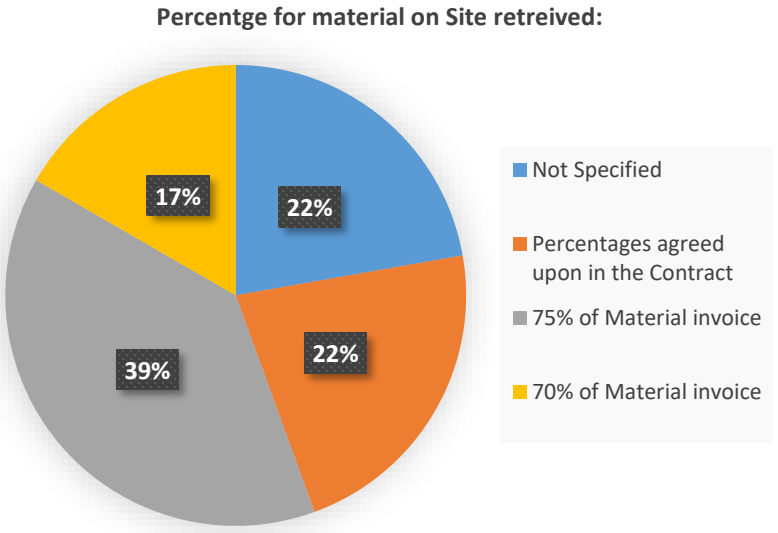


Figure 16: Allowed percentage for material on site

In options A & B the Employer allow the contractor a fixed percentage approximately three quarters of the **invoice** paid upon delivery, and these are the options stated in more than half of the contracts. Therefore, if the contract includes these

percentages the contractor is supposed to have a steady cashflow. Option C was observed in 22% of the contracts and this allowed the contractor to negotiate some of the items and agree on the percentage to be paid for these items.

Similarly, for Architecture and Electromechanical works, that require several stages of installments, such as the installation of the Electromechanical works in an office building, that will need require the Supervision Consultant to first inspect the conduits then the wiring elements followed by the installation of the electrical socket. 62% of the contracts included a provision to allow the contractor to get partial payments for these works. These partial payments were either agreed upon in the contract and the contractor can negotiate these items once again to attain a distribution of monies that better suits the cashflow. Else, in 27% of the contracts, it was stated that the contractor 60% of BOQ rate for the architecture works and 50% of BOQ rate for MEP works. While only 5.5% of the contracts entitled the contractor to 40% of BOQ rate for architecture works and 50% of BOQ rate for MEP works.

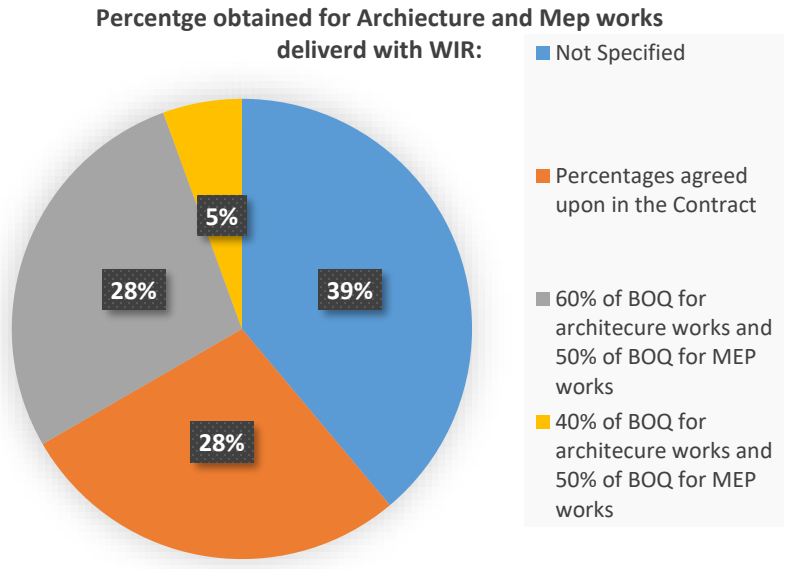


Figure 17: Allowed Percentage for delivery of Architectural and MEP items

4.2.3 Category 3: Operations:

This category covers the contractor's duties and obligations throughout the project durations. The risk entailed with this category may vary from one contractor to another depending on the managerial capabilities of each contractor, the size of projects that the contractor is custom with, & the capacity of each contractor. This category covers 5 main sub-categories, and they are the Commencement of works procedure, the Submission of Program of works, the Taker over procedure, the Insurance, and the Contractor duties. The results of this sections present the most common procedures & obligations obtained from analyzing the terms related to contractor duties & from the results of el Hotieby (2017), that might put the contractor at risk if the contractor could

not abide by it. However, some contractors might find one or more of these sub-categories as risk-free terms, and thus each contractor will have to analyze from their perspective the significance of these terms.

Observations:

1) One of the main findings of El Hotieby (2017) is that contracts do not usually entail a provision specifying whether obtaining site possession is condition precedent for the commencement of works or not, and similarly whether receiving the advance payment by the contractor is a condition to commence the works. These two provisions protect the contractor's liability against any claim from the Employer because of the contractors delay in proceeding due to not receiving the advance payment or not being able to access the site. Hence, these provisions were added to evaluate to the list of terms to see if the contracts nowadays have included such provision.
2) The contractor's liability extends to all structural elements and all the works done by the contractor. This abides by the article 651 of the Egyptian Civil Code which holds the contractor liable for the total and partial collapse of a structure even if the damages were due to the soil conditions for a period of 10 years, while the decennial liability begins from the date of the Employer's taking over of the works.
3) The Submission of progress reports was found to be every month for all the analyzed contracts and therefore, contractors must adapt to ensure it is submitted, thus it was omitted from the list.
4) It was noted that all contracts required the contractor to complete all the tests as a condition precedent to the taking over.
5) The costs of issuing and maintaining all insurance required by the Employer is borne by the contractor, therefore, it was removed from the list of terms.

Analyses of Numerical Terms:

The allowed duration to commence works is calculated from the stated commencement date in the contracts. The table 11 below, shows the statistical analyses of these results. The contracts revealed that Employers allow the contractor a period from 7 to 21 days to proceed with the mobilization and begin working on site without claiming any delays. The distribution of results for this term is demonstrated in figure 18 and is deviated more towards the 7 days. The risk of such provisions depends on the contractor's managerial ability to direct resources to the site on such short period. While this term, lacks relation to whether the contractor has received the site possession or the advance payment or not, therefore these terms should be analyzed together.

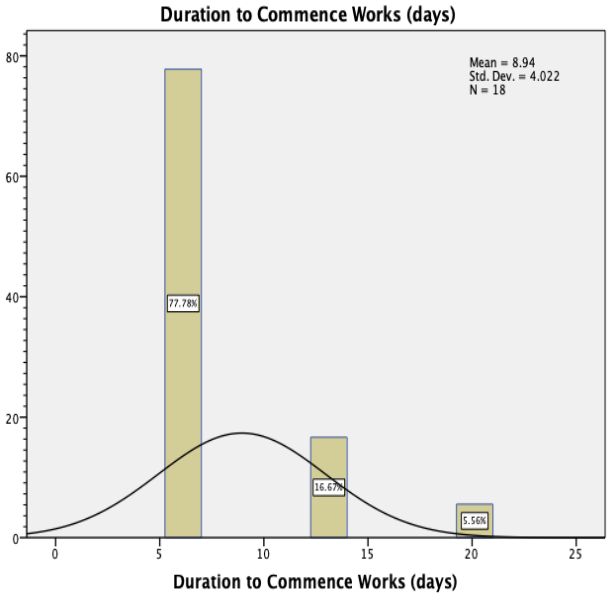


Figure 18: Distribution of results for Duration to commence Works

Table 11: Numerical results for Operations Provisions

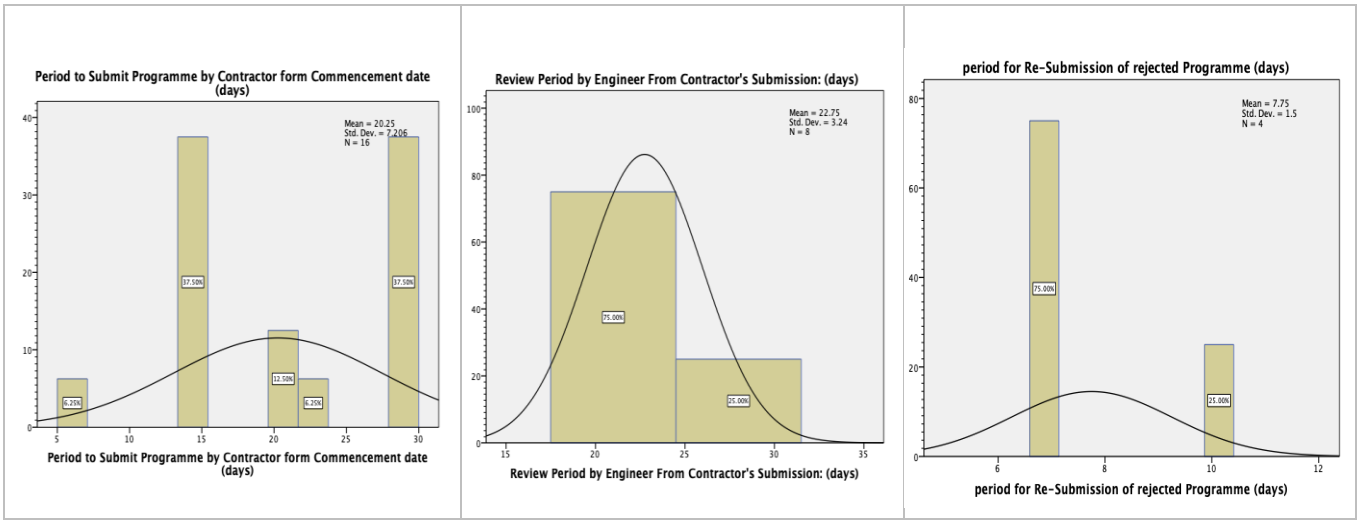
		Duration to Commence Works (days)	Period to Submit Program by Contractor form Commencement date (days)	Review Period by Engineer from Contractor's Submission: (days)	period for Re-Submission of rejected Program (days)
N	**18**	16	8	4	17
	0	2	10	14	1
Mean		**8.94**	**20.25**	**22.75**	**7.75**
Median		7.00	21.00	21.00	7.00
Mode		**7**	**14[a]**	**21**	**7**
Std. Deviation		**4.022**	**7.206**	**3.240**	**1.500**
Variance		16.173	51.933	10.500	2.250
Skewness		2.072	-.199	1.440	2.000
Std. Error of Skewness		.536	.564	.752	1.014
Range		14	21	7	3
Minimum		**7**	**7**	**21**	**7**
Maximum		**21**	**28**	**28**	**10**

Submission of Program of Works: most contracts allowed the contractor a period of 14 days from commencement date to submit a detailed program of works for approval. While the mean duration was discovered to be 21 days. The submission of detailed program within this duration requires the contractor to obtain a planning team for the project at an early stage. It is crucial to note that having a realistic, detailed program is of great benefit to both the employer and the contractor in evaluating any delays. Furthermore, for complex large-scale projects this duration might not be sufficient to study and evaluate all the relationships between the activities to produce a realistic program of works. Each contractor must ensure that the stated duration is sufficient and that they can abide by it, as the contract may include a provision to penalize the contractor as seen in table 12.

The majority of the contracts did not specify a specific duration for the Supervision Consultant to review the submitted program of works. However, the discovered period to review the program ranged from 21 to 28 days and to issue any comments or approve the program that will be utilized for the remaining part of the project.

In case of rejection, the contractor is entitled to a short period ranging from 7 to 10 days to adjust the program, negotiate all the comments and re-submit the program for approval. The charts below show the distributions of results for each of these terms.

Table 12: Distribution of results for Operations Provisions



Analyses of Binary Terms:

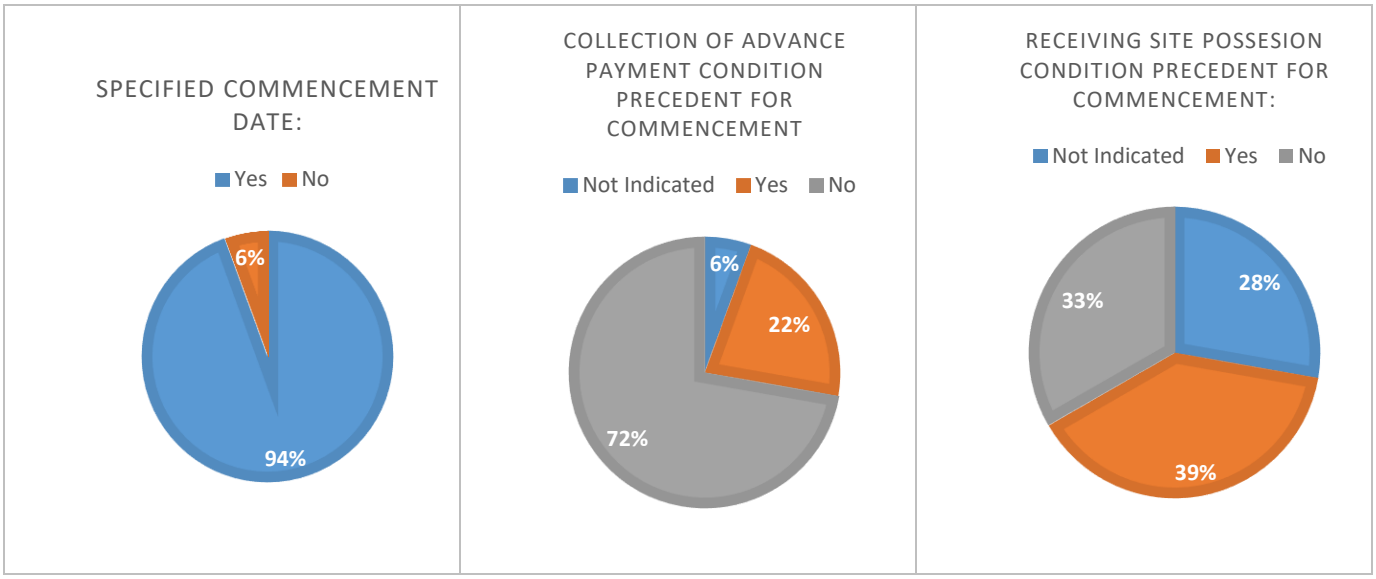
1) Commencement of Works:

A. 95% of the contracts analyzed had a specified commencement date stated in the contract. This is important in creating the program of works and acts as the starting date of the project. Contractors should ensure that the commencement date is after the contractor receives the advance payment and receives the site possession.

B. Only 22.2 % of the contracts had a provision entitling the contractor to receive the advance payment as a condition precedent to the commencement date. While 72% of the contracts did not incorporate any provision to allow the contractor to delay the commencement or to claim for financing costs if the advance payment is delayed, which complies with the findings of El Hotieby (2017).

C. On the other hand, 39% of the contracts required the contractor to receive site possession even it was partial site possession as a condition precedent to the contract. While 33% of the contracts did not relate the site possession to the commencement date or had another date specified. The remaining 27% of the contracts were divided between contracts with no commencement date stated and contracts with no provision for site possession.

Table 13: Pie Charts for Commencement of works Provisions



2) Taking Over certificate:

61% of the contracts required the submission of the As-built drawings operations and manuals prior to issuance of the taking over certificate. While as stated earlier, all the contracts had the completion of tests as a condition precedent to the Taking over certificate. This requires the contractor to ensure that all the necessary documents are submitted, while if the contractor can avoid having the submission of as built drawings and operations and manuals as a precedent, it will enable him to receive the taking over certificate and start the defects liability period as early as possible while having more time to complete the necessary documents.

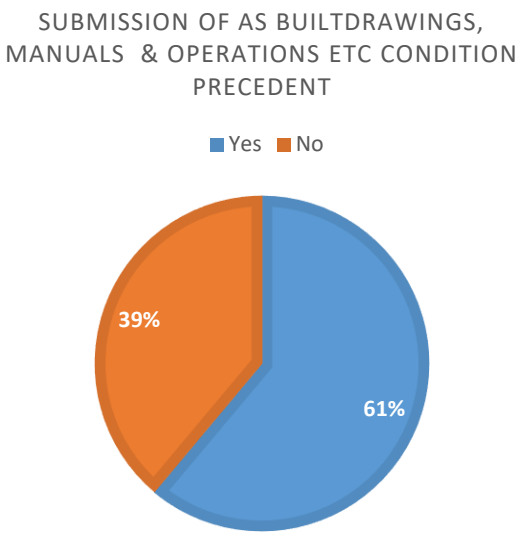


Figure 19: Submission of As-built Drawings and manuals as condition precedent

3) Contractor Duties: three main contractor duties where explored, which are related to the contractor's obligation to confidentiality, the contractor obligation to inherent any defects after termination and finally, the obligation to submit a cost breakdown for every item either after commencement or upon the contractor's requests.

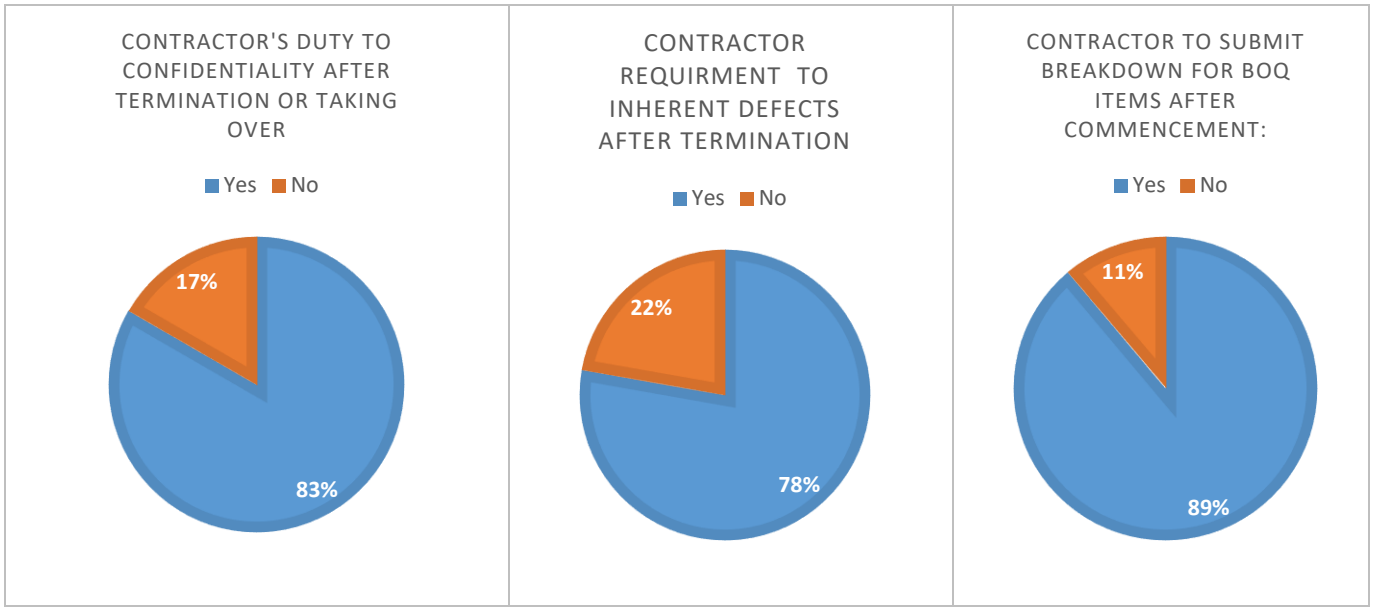
A. 83% of the contracts obliged the contractor to confidential agreements throughout the project and after handing over or termination. Especially, because several employers may be issuing different projects to tenders and dealing with several contractors at the same time.

B. After the 2011 & 2013 political events in Egypt and the 2016 devaluation of the currency, lots of projects experienced severe delays and some projects were terminated for the inability of the contractor to proceed or for the convenience of the employer. Therefore, the dilemma that arose was whether the contractor is obliged to inherent any defects even after the termination. 77% of the contracts analyzed required the contractor to restore any defects that appears in the projects as a result of the contractors' fault. While 22% of the contracts lacked the presence of such clause.

C. It was observed that some contracts required the contractor to submit a cost breakdown for any BOQ item even though the project is on Lump-sum basis. This breakdown is supposed

to be used in valuation of variations and not to re-evaluate the contract price. It was noted in 89% of the contracts that the contractor is obliged to submit this breakdown after the commencement of the project or upon the employer's request.

Table 14: Pie charts for Contractor Duties Provisions



4) Insurance:

A. The contractor is the party that bears the costs of issuing and maintaining all insurance throughout the contract period.

B. 77.8% of the analyzed contracts entitled the employer for a notice from the insurers prior to making any changes or to renew the policies. The usual notice period indicated in the majority of the contracts is 28 days prior to making any modifications.

C. 89% of the contracts required the contractor to insure against the loss or damage of any plant prior to its delivery and unloading on Site, to protect the employer against any claims.

D. 61% of the Employers required the contractor to obtain a waiver from the insurance company for any right of claim against the employer. While a similar 61% indicated that the contractor should also indemnify the employer against all losses or claims that arise because of the contractor's default and failure to comply with the insurance policies or any of his sub-contractors during the contractor working period on site.

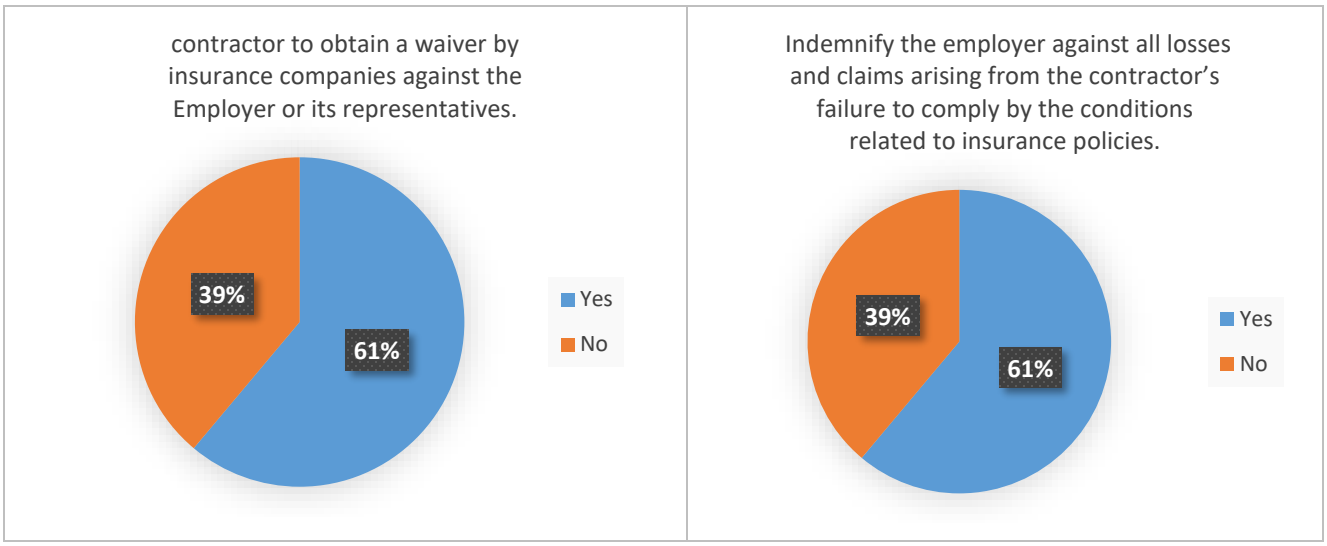


Table 15: Pie charts for Insurances Provisions

Analyses of Descriptive Terms:

Submission of Program of works: As mentioned above, several contracts required the contractor to submit a detailed program of works after commencement for approval. However, what if the contractor did not submit the program or was delayed in completing and obtaining its approval. Some contracts include a provision to penalize the contractor until the program of works is complete. Seven different variations were detected, and they can affect the cashflow of the project severely, and they are:

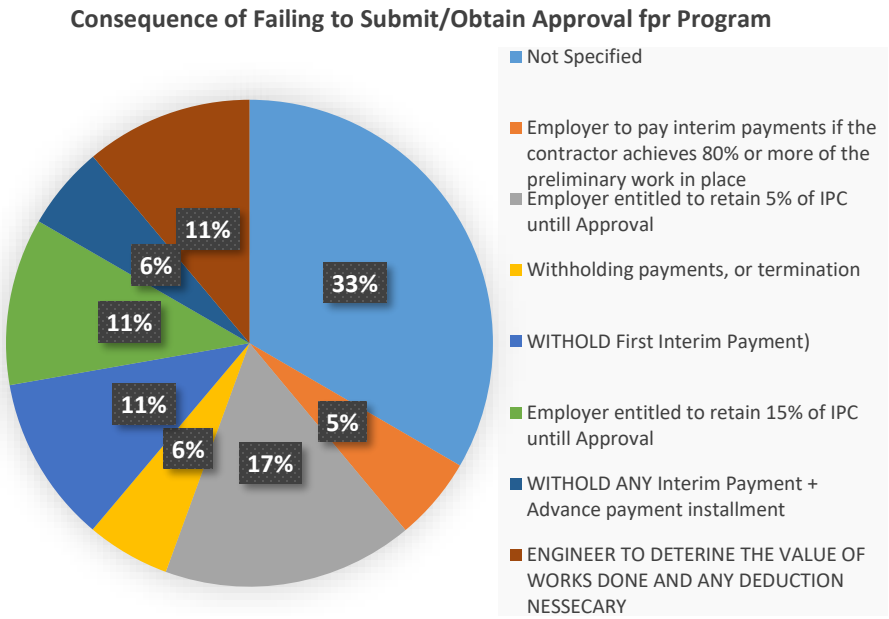


Figure 20: Pie chart for Consequences for failing to submit a program

A. Employer is only obliged to pay the interim payments if the contractor achieves 80% or more of the preliminary work in place.
B. Employer entitled to retain 5% of IPC until Approval.
C. Employer is entitled to withhold payments, or termination.

D. Employer is entitled to withhold First interim payment.
E. Employer is entitled to retain 15% of each Interim payment until approval.
F. Employer is entitled to withhold any Interim payment plus Advance payment installments.
G. Engineer can determine the value of works done and any deductions necessary.

Option A opts to utilize the preliminary work in place included in the contract documents, that indicates how much work needs to be done to conclude the project. However, this document may not be accurate or did not include all the works. Meanwhile, options B & E which were found in 26% of the contracts entitles the contractor for partial payments, while a percentage between 5 to 15% will be withheld from each payment certificate until obtaining approval. Options C, D & E, allows the Employer to retain full payments until approval, in addition to withholding the advance payments installments if any, and if the contractor did not submit the program the employer can terminate the contract. Finally, Option G with was found in 11% of the contracts allows the Engineer/Supervision Consultant to evaluate the works done and the performance of the contractor and decide on the necessary percentage of deduction.

Taking Over Procedure:

Several projects may be handed over to the Employer in phases, with the Employer issuing a taking over certificate for each phase separately. However, it was noted in some projects that the employer may opt to utilize parts of the project before the taking over. In such case, it is important to determine the liability of each party. In 11% of the contracts the contractor is obliged to protect and repair any works that has been utilized by the employer or any of his representatives before the taking over. While, in 16.6% of the projects analyzed allowed the employer to use parts of the projects but not for the purposes it is intended to, for instance requiring a space for storage. Thus, the contractor is still responsible for its care,

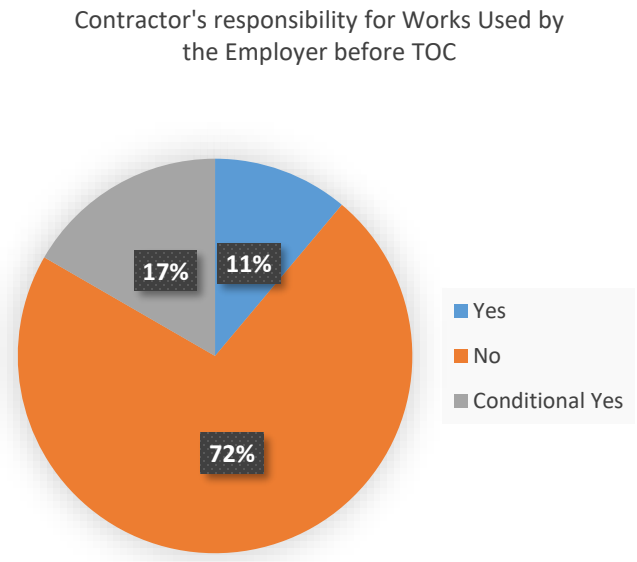


Figure 21: Pie chart for Contractor's responsibility to maintain works used by the Employer

however if the employer requested part of the project to be operated for its main purposes, then any damages that may occur shall be borne by the employer.

On the other hand, many of the projects released the contractor from this burden and allowed the contractor to claim for any damages that are occurred by the employer before the taking over. This option implements the rules of the Egyptian Civil Code Article No. 665 Paragraph 3 and protects the right which states *"If the works destroyed are due to the employer's fault or failure to take delivery of the works or due to a defect of the materials supplied by him. The contractor is entitled to his fees plus compensation"* this protects the rights of the contractor and reduces the risk on his burden.

Finally, in case of taking over of a portion of works, the earlier the contractor can retrieve the retention amount the more cash is available and the less risk. 55% of the projects entitled the contractor to earn half of the retention amount for this portion of works. While 5.5% returned 40% to the contractor and the rest to be released about the final taking over. The optimum option for a contractor is to retrieve full amount of the retention which abides by Article 248 of the Egyptian Civil Code, that allows the contractor to retrieve the retention upon delivering his obligation, this was found in 16.7% of the project. While the most extreme of all was in 22.2% of the projects which denied the contractor from any of the retention amounts until final taking over.

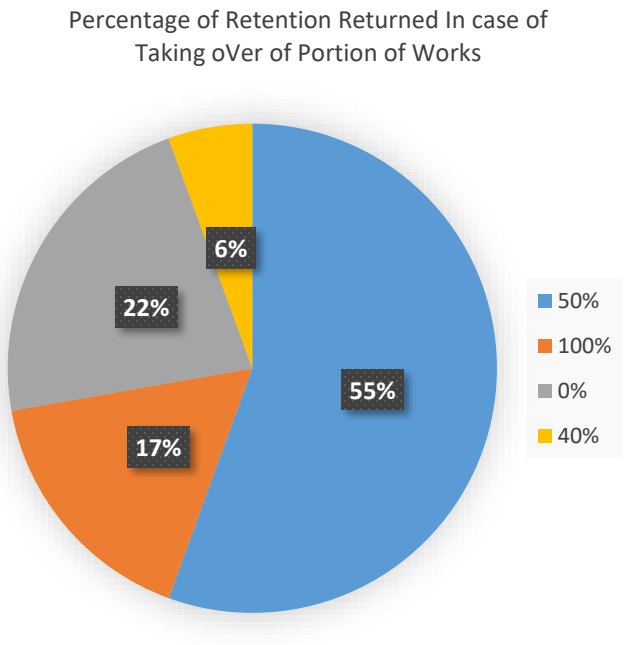


Figure 22: Pie chart for Percentage of retention returned upon taking over

4.2.4 Category 4: Claims and Variation:

It is customary in any project for the Employer to request variations during the project, however disputes usually arise due to the lack of clear evaluation techniques for variations, or due to the fact that the contractor did not fully comprehend the claims and variations procedures and did not abide by it. The causes of variations have been reviewed in literature by several researchers

and is not the purpose of this category. This category focuses on breaking down and isolating the main provisions for claims and variations, that allows the contractor to understand any time bar limitations and the variation evaluation techniques incorporated in the contract.

Observations:

1. None of the contracts analyzed clarified all the variation scenarios and their evaluation as indicated in chapter three. Many of the contracts stated that if the item is indicated in the BOQ then the same rate shall be used. Else if their works requested is not included and there exists a similar item it shall be used for evaluation purposes. Finally, the Engineer may determine the price that he considers to be fair and/or the parties are to agree on it.
2. The contractor should always ensure that the variation order is issued from the party with the authority to make such changes, and that this party is clearly stated in the contract.
3. All the contracts had the cost of proposal, studies and value engineering borne by the contractor. While in value engineering, the contractor is entitled to monies after he proves that the modifications will save a significant amount of money and is approved by the Employer. Until then all costs are borne by the contractor.
4. All the contracts obliged the contractor to proceed with the variation instructions promptly, even before agreeing on the price.

Analyses of Numerical Terms:

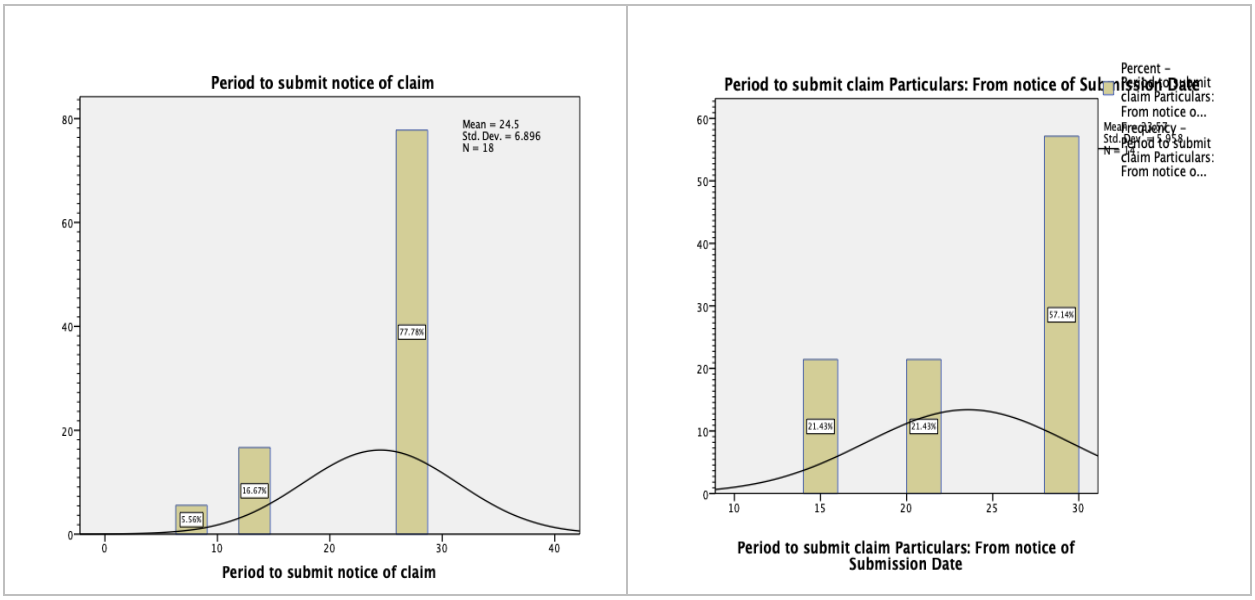
1) Claims: the notice to claim is a mean of communication, submitted by the contractor to notify the Employer and the Project Manager with any incident that will affect the progress of works and/or will induce additional costs. According to the research conducted by Abdul-Malak (2017), the notice to claim is most frequent notice type implemented in construction, while the notice of claim is a time barred notice that should be dealt with diligence to ensure the contractor rights are protected. It was discovered that the period to submit notice of claim ranged from 7 days to 28 days. Whereas most of the contracts had the notice to claim period of 28 days to allow the contractor to understand the impact of the event before submitting the notice. A period of 7 days will require the contractor to promptly consider and submit a notice for every event. The distribution of results is leaning towards the 28 days with a mean value of 24 days. Therefore, the shorter the duration, the more hassle the contractor will endure.

Following the notice to claim, the majority of the contracts required the contractor to submit a detailed particular of the claim within a certain period, involving another time bar. the most common result was having another 28 days for the contractor to completely analyze the incident and submit its consequences from the date of the notice submission. However, the results showed a range of values from 14 days to 29 days. The distribution curves in table 17, show a wider more dispersed results with an average of 24 days.

Table 16: Numerical results for Claims & Variations Provisions

		Period to submit notice of claim	Period to submit claim Particulars: From notice of Submission Date	Duration to Submit Notice of variation:	Percentage of overhead and profit to be used for evaluation purposes.	Value Engineering Benefit: Contractors Entitlement from Cost reduction:
N	**Valid**	18	14	15	12	15
	Missing	0	4	3	6	3
Mean		**24.50**	**23.57**	**21.93**	**20.208**	**34.67**
Median		28.00	28.00	28.00	22.500	30.00
Mode		**28**	**28**	**28**	**25.0**	**25**
Std. Deviation		**6.896**	**5.958**	**6.933**	**5.6867**	**11.412**
Range		21	15	14	15.0	25
Minimum		**7**	**14**	**14**	**10.0**	**25**
Maximum		**28**	**29**	**28**	**25.0**	**50**

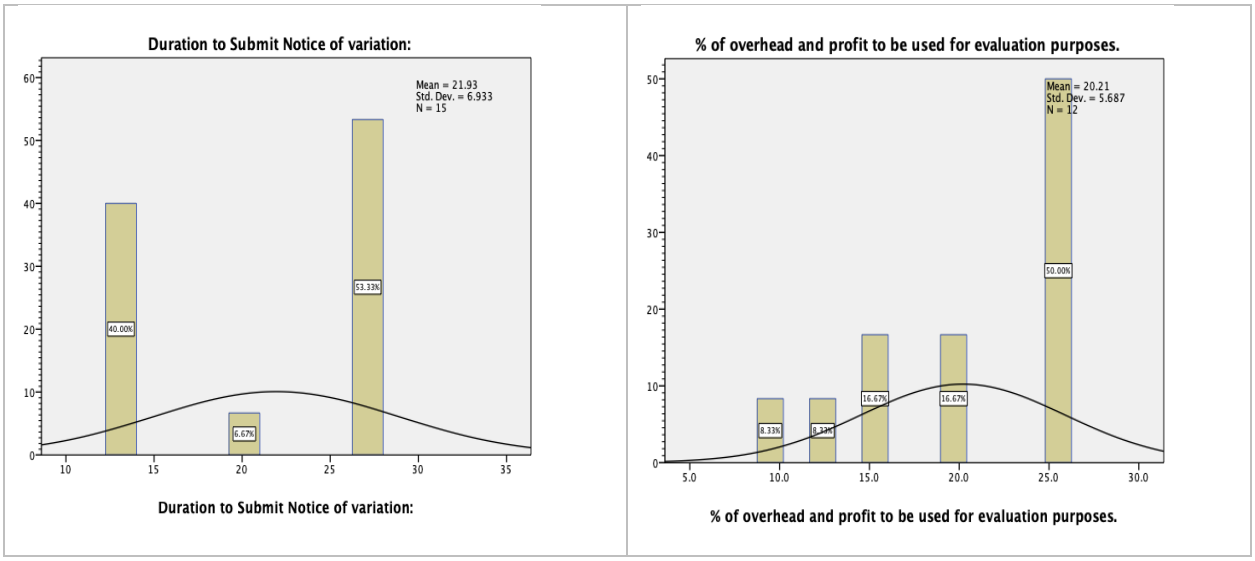
Table 17: Distribution of Period to Submit notice to claim.



2) Variation: another time bar included in almost all the contracts was the notice of variation. During the construction, the contractor may receive instruction to modify certain aspects from a party that is not entitled to issue a variation order. Hence the contractor is obliged to notify the Employer before proceeding with such actions. The notice of variation should be issued within 14 to 28 days from the date of the instruction or incident. The majority of the contracts allowed a period of 28 days similar to the notice to claim with a mean value of 22 days.

   One of the most important provision in variations that should be agreed upon and stated in the contract for the evaluation, is the allowed percentage of profit and overhead to be added by the contractor in evaluating the variations. Results showed that the highest percentage for overhead and profit was 25% and this was the most frequent results however other percentages appeared ranging from 10% to 25%. This percentage will be used in evaluation of work items that are not included in the BOQ; thus, a higher percentage will be beneficial to the contractor.

Table 18: Distribution for Variation Provisions



3) Value Engineering: As mentioned earlier the cost of value engineering is borne by the contractor, however, to encourage the contractor to implement value engineering the contracts involves an incentive provision entitling the contractor to a percentage of the cost reduction. The results showed that the incentive percentages ranged from 25% to 50% of the cost reduction occurred, with the mean value of 34%. The distribution curve showed the result leaning towards the 25%, however there was a high frequency of contracts that had a 50% incentive indicated. Thus, if the contractor upon studying the project contemplates that he can induce significant cost reduction then he shall negotiate for the higher value.

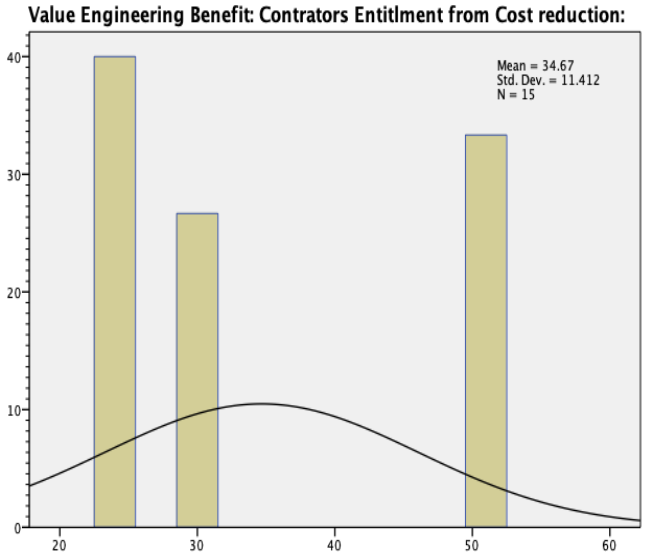


Figure 23: Percentage of Contractor's Entitlement for Value Engineering

Analyses of Binary & Descriptive Terms:

1) Lowest Claim Value: It was noted in 22% of the contracts that some Employer's restricted the contractor's claims by adding a provision that requires the claim to meet a minimum value before the contractor can submit it. The minimum value noted in the contracts was fifty thousand Egyptian pounds which is equivalent to three thousand four hundred US dollars. In large scale projects this value may be considered minimal and does not impose significant risk. Thus 78% of the projects omitted this provision for its low significance.
2) Percentage of allowed variations: the results were split for this term, half of the projects analyzed calculated the allowed variation for each BOQ item separately. It was noted that the stated allowed variation from every BOQ item is 25% before the contractor can negotiate a new price and no other percentage was found. While the other half of the projects calculated the percentage of allowed variations from the full contract value. Which means that the employer is entitled to make variation in all items of the BOQ.

   The results showed that the percentage of allowed variations in the contract value where either 20% which was stated in 11% of the contracts that had that variations from the contract's value or 25% which was available in most of the projects with the variations

calculated from the contract value. The contractor might not be able to negotiate adopting the variations from the Contract price or from the BOQ item but can try to reduce the percentage of allowed variation, as it was stated as one of the main causes of delay and disputes.

3) Evaluation of variations: none of the contracts analyzed included a detailed for the evaluation of variations with all the different scenarios, however the contracts revealed that they include only three different scenarios for the evaluation of variations that are very similar to those incorporated in the FIDIC 1999 provision. While any deviations are left for the engineer to determine the appropriate evaluation.

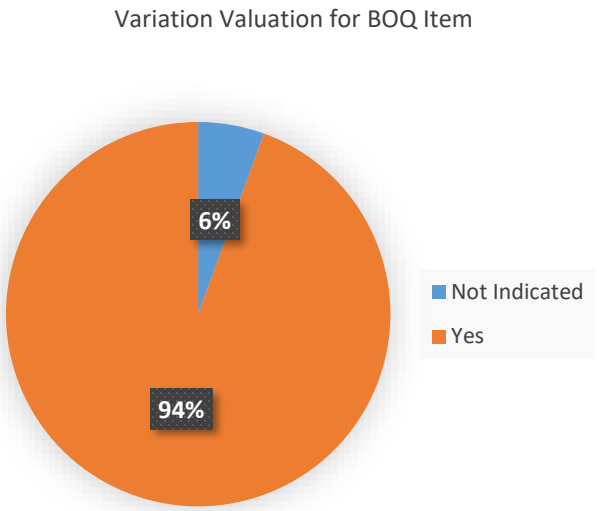


Figure 24: Pie chart for evaluation of Variations

A. In the first scenario 94.5% of the projects analyzed allowed the same BOQ rates to be used be used for items that are already stated in the BOQ. While the remaining projects stated that any variation is left to the Engineer to determine the appropriate prices.

B. In the Second Scenario, where the item is not included in the BOQ, but a similar item is available, 88.9% of the contracts indicated that the BOQ item shall be used for evaluation purposes. Whereas 11.1% of the contracts stated that it shall be dealt with as a new item and the contractor can submit a new price to the engineer for determination.

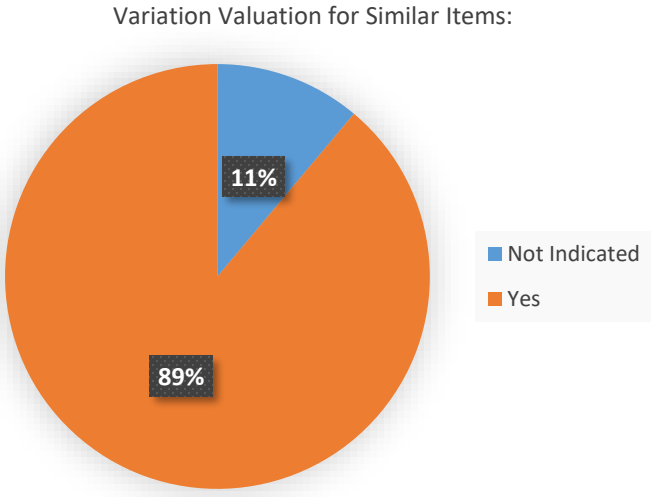


Figure 25: Pie chart for evaluation of variations

C. the third scenario is used for the evaluation of a new item, which required the contractor to submit a new pricing for the engineer. However, until a price is set 38% of the contracts entitled the contractor to a provisional amount. While 16.7% of the contracts obliged the engineer to determine a price to be used in the evaluation and if the contractor does not accept the price, the contractor can submit a notice of dissatisfaction. While the last option that was included in 33% of the projects required all parties to agree on the price (Mutual Agreement), and no sole party can set the determination.

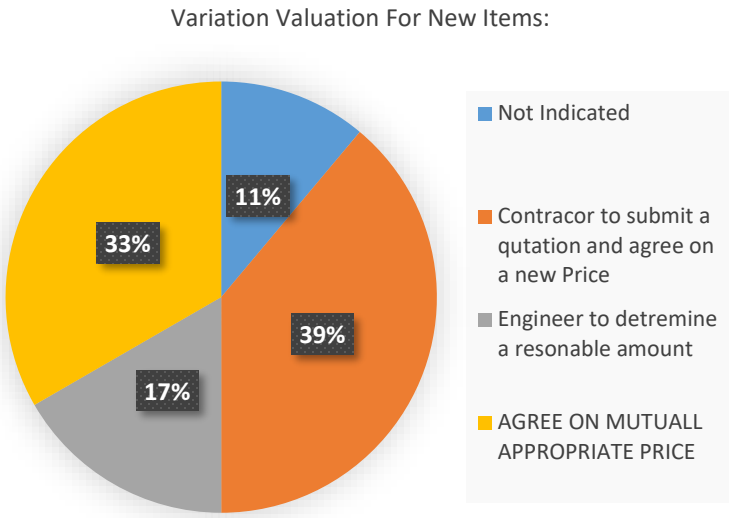


Figure 26: Pie chart for evaluation of Variations

4.2.5 Category 5: Liquidated damages and Extension of Time:

This category analyzes how the contractor can apply for an extension of time and the application of liquidated damages and other penalties on the contractor. And how can the contractor retrieve these amounts according to the Egyptian civil code. Identifying these clauses enlightens the contractor with the consequences of any delays and the severeness of the loss that may occur if the liquidated damages are applied. While, understanding the Egyptian Law can protect the contractor against any unjustified deductions. This category is divided to three sub-categories, Extension of time, Intermediate Milestones and Liquidated damages.

Observations:

1) All gathered contracts incorporated a liquidated damages provisions that are due to the employer in case of any contractor delays.
2) Some contracts had several intermediate milestones that should be achieved in addition to the final contractual milestone.
3) Several contracts had stated that “Time is of the Essence” to emphasis the importance to complete the project on time. While this phrase from a legal perspective incorporates a risk

that should not be dealt with lightly, as it can allow the Employer to terminate the contract if the project is severely delayed or claim for lost profits as a result of not meeting the obligation.

Extension of Time:

All contracts provide the contractor with the mechanism to claim for extension of time for any delays outside of the contractors' control. However, there are some common conditions that can leave the contractor in a better position and avoid the application of liquidated damages if they are included in this provision. Such as:

A) The Availability of Grace Period: this is a duration after the contract completion date that is stated in the program, in which the contractor can utilize before the employer can enforce any liquidated damages. This period acts as a safety rope for the contractor delays, as it enables the contractor to complete any outstanding works after the contract completion date. The presence of such period in the contract is of great benefit, an if a contractor during negotiation can include such a period, it will minimize the risk of delays. 22.2% of the contracts had a grace period included while the majority abided with the agreed completion date.

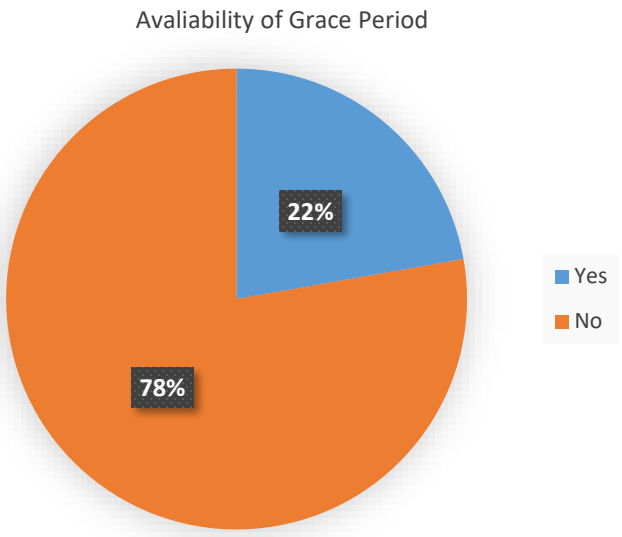


Figure 27: Availability of Grace Period

B) Can the Engineer take into account the omitted works: several researches have addressed this topic, while the absence of definitive answer, makes it subject to the project engineer's determination. Thus, it is crucial to be indicated in the contract to avoid disputes. 50% of the analyzed projects allowed the engineer to take any omitted works into consideration when evaluating an extensions of time claim. While 22.2% of the projects rejected this accusation and stuck to project duration. Furthermore, 5.56% of the projects included a condition that allows the engineer to consider the omitted works in evaluation, however, the engineer may not reduce any previously granted extension of time. The remaining 22.2% lacked the presence of such provision.

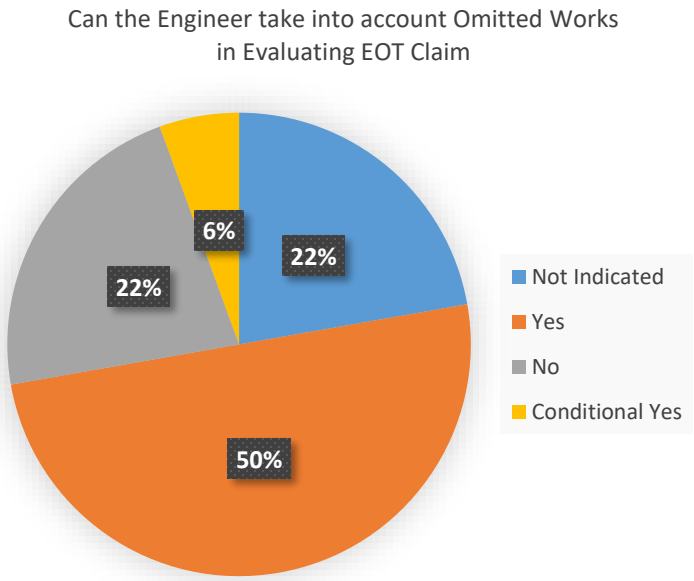


Figure 28: Omitted works in determining Extension of time

C) Can the Contractor claim Extension of Time for Insufficient design documents: a common issue that faces many contractors, is insufficient or unclear design documents, which during the execution, the contractor has to raise several inquiries and may have to make several modifications that were not accounted for due to the poor design documents. Whereas as the design is supplied by the employer, 55.5% of the contracts enabled the contractor to claim for extension of time if he proves that its due to the design supplied and he took all the necessary measures to acquaint himself with the design. While the remaining 44.5% required the contractor to study the documents and raise any

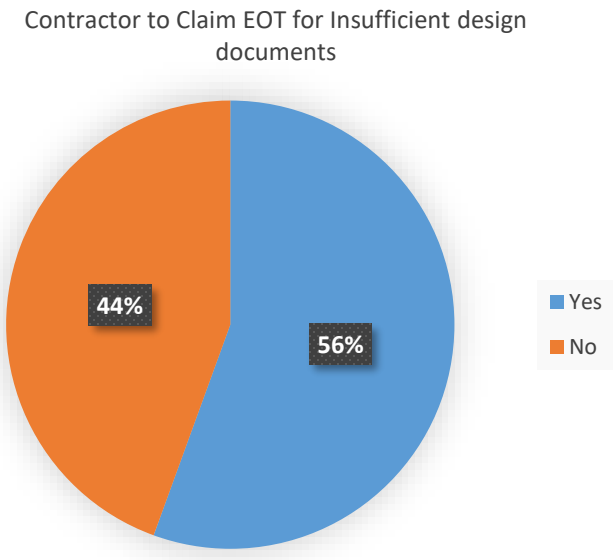


Figure 29: contractor to claim Extension of time for Insufficiency of design

concerns during the tendering stage or during the first few month of the project. And if any issues arise after that, the contractor is liable for this delay.

The Egyptian Civil Code article no. 157 Paragraph 2 provide the contractor the capability to gain additional time to complete his obligation in case it was not stated in the contract. Furthermore, the court may reject the rescission of the contract for nonperformance, if the non-performed activities are of little importance compared to the main obligation and allow the contractor to complete his works.

Milestone:

Each project has a final completion contractual milestone and may have several other milestones for different sections of the project. The milestones allow the employer to assess the progress of the contractor and ensure that the project is progressing according to the schedule of works. 72.2% of the contracts analyzed had several intermediate milestones indicated on the schedule of works. Meanwhile, it was noted that some contracts incorporated a penalty if the contractor did not achieve the intermediate milestone. Though the penalty indicates the deduction of amounts for not meeting the goal, the enforcement of penalties or any punishment under the Egyptian civil code is not tolerated. Whereas the Egyptian laws allows the debtor to only claim the damages that he encountered. Therefore, the lack achievement of an intermediate milestone shall not incorporate any damages. 61.1% of the contracts analyzed had a penalty induced as a sort of punishment for not meeting the milestone. On the other hand, 27.8% the contracts showed that the penalties provision is stated in the form that withholds certain amounts of monies for every day of delay until the contractor proves the completion. Afterwards the contractor can redeem the withheld amounts upon reaching the subsequent milestone. The remaining 11.1% did not include a penalty provision, which is the least risk factor to the contractor.

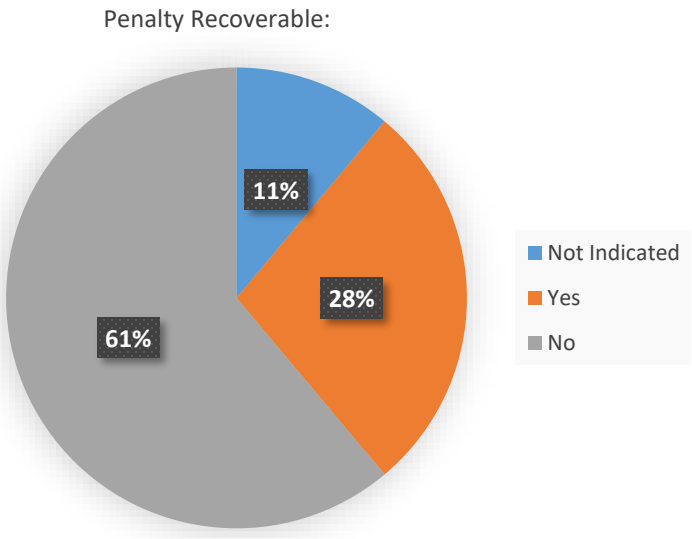


Figure 30: reimbursement of Penalties

Finally, the penalties induced on the contractor where:

1) Deduction of 10,000EGP per day or
2) Deduction of 25,000EGP per day or
3) Deduction of 100,000EGP per day

The results showed that the first penalty which is equivalent to 650 US dollars per day was found in 11.1% of the contracts. While the second penalty which is equivalent to 1600 US dollar per day was discovered in 22.2% of the projects. While the last penalty and the most stringent of all which is equivalent to 6450 US dollars per day appeared in 5.5% of the projects. The remaining projects lacked a penalties provision.

Liquidated damages:

In case the contractor is delayed to performing his obligation, the employer may enforce the liquidated damages clause which is incorporated in all the contracts analyzed. The purpose of this clause is to reimburse the employer for any damages that he has encountered because of the delay and for not being able to benefit from the project during this period, and not as a punishment for the contractor. These damages should be quantified, and the employer should be able to demonstrate it in court in case the contractor resolves to litigation. Article 224 of the Egyptian civil code which states *"Damages fixed in the contract can be avoided or reduced if the Debtor Proves that the creditor did not experience this harm"* allows the contractor to claim any deduction enforced by the employer if he assures that the deductions made are not equivalent to the damages. The liquidated damages clause is usually capped to maximum percentage for the delay unless gross negligence was proven.

A) The maximum percentage of Liquidated damages applied in Egypt: 88.9% of the projects had enforced 10% liquidated damages of the contract value for the entire project or for the section of works delayed. i.e., if the contractor had handed over the first phase of the project and is delayed in the second phase, the 10% is calculated from the value of works of the second phase only.

   It was found in 5.5% of the projects that the maximum Liquidated damages is 10% however, the contracts allow the employer to deduct the engineer fees that will be paid to complete the works during the delayed period plus any additional costs incurred to

complete the works. The remaining 5.6% of the projects had enforced a maximum of 5 percent liquidated damages of the contract value. Which reduces the cap for damages and reduces the risk on the contractor.

B) The results showed several different means for the application of Liquidated damages, with some being more stringent than the other. The table below demonstrates the different option and the frequency of their occurrence.

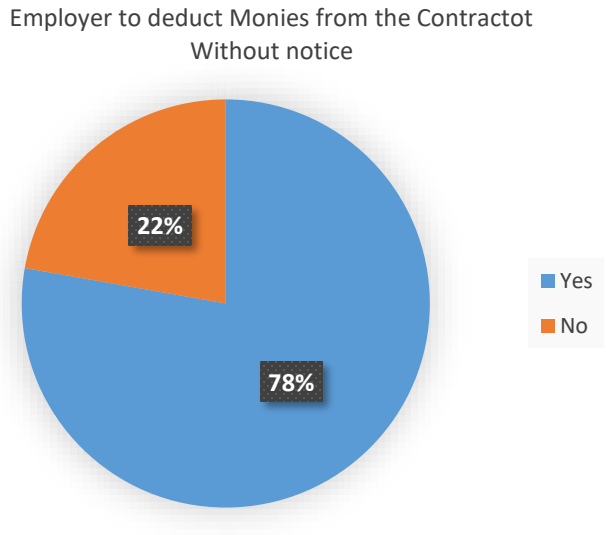


Figure 31: Employer ability to deduct monies from the contractor

Option 1 is the most implemented provision with equal damages of 1% per week for a maximum value of 10%. Option 2 is a leaner application with 0.5% damages per week allowing the maximum delay period to be 20 weeks. Option 3 was discovered in the contracts with 5% maximum damages and allowed a maximum delay duration of 60 days which is close to option 1 but with fewer damages. option 4 is the most stringent application with 2% damages calculated for every week allowing the maximum delay to be 5 weeks rather than 10 weeks. Options 5 & 6 have broken down the damages and implemented an incremental system allowing the contractor fewer damages for the first week and is raised as the period of delays increases.

Table 19: Liquidated Damages Provisions

No.	Application of Liquidated Damages	Percentage
1	1% per week for a maximum of 10 weeks	50%
2	0.5% per week for a maximum of 20 weeks	16.67%
3	1/12% per day for a maximum of 60 days to reach 5%	5.56%
4	2% per week for a maximum of 5 weeks	5.56%
5	0.5% FOR 1ST WEEK, 1% FOR 2ND WEEK, 1.5% FOR 3RD WEEK, 2% FOR THE 4TH WEEK, 2.5% FOR THE 5TH WEEK, 2.5% FOR THE 6TH WEEK	16.67%
6	Fixed Amounts A) 50,000 Per day for 10 days B) 100,000 Per days for the following 10 days C) 150,000 per day till the end of the amount.	5.56%

C) Finally, several contracts allowed the Employer to deduct monies form the contractor during the project without prior notice and without giving the contractor time to rectify his works. This provision adds a significant risk factor on the contractor that should be avoided during negotiating the contract provisions. This provision was discovered in 77.8% of the analyzed projects.

4.2.6 Category 6: Limitation of Liability and Dispute Resolution:

The previous provisions where to allow the contractor to work efficiently without disputes, however no construction project or contract can guarantee a dispute free project. While every contract should provide means to resolve the arguments without putting the contractor's liability at risk. This category examines the limitation of liability provisions present in the contracts in Egypt, and the different dispute resolution mechanism implemented.

Limitation of Liability:

The limitation of liability clause protects the contractor's financial status and limits the risk, by putting a cap on the amount of damages that the employer can claim in case of disputes. An example of a limitation of liability provision that was included in the FIDIC 1999 red book is *"neither party shall be liable to the other party for loss of use of any works, loss of profit, loss of any contract or for any indirect or consequential loss or damage which may be suffered by the other party in connection with the contract"*. The limitation of liability provision may

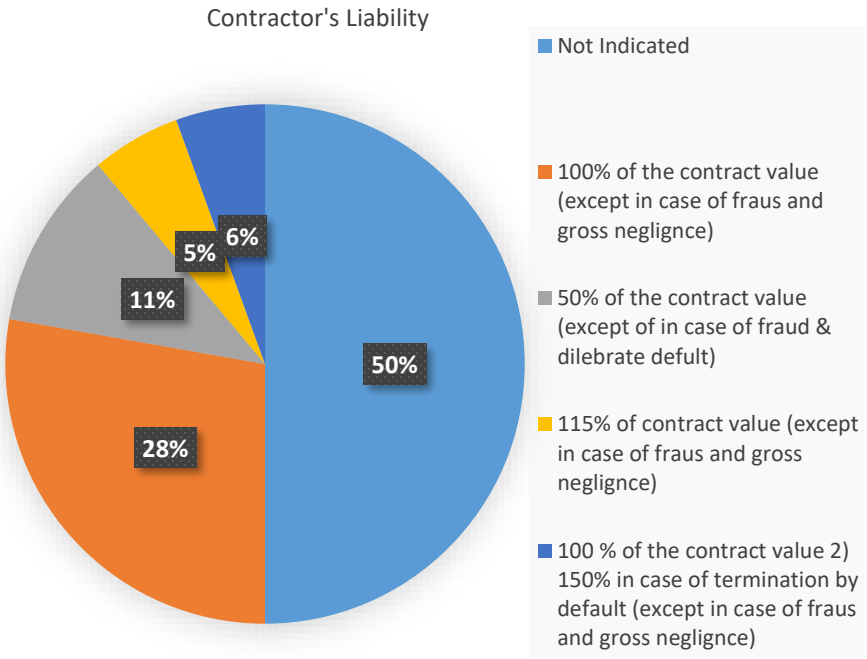


Figure 32: Contractor's Liability Provisions

not stand in court in case of any fraud, deliberate default, or gross negligence by any party. The results showed that only 38.9% of the projects had included a limitation of liability provision while the remaining projects lacked any indication for such limitation increasing the risk on the contractor.

There are four different results for the limition of liability provision discovered in the analysed contracts (figure 32). The first limited the contractor's liabity to 100% of the contract value and was stated in 27.7% of the contracts , Which is similar to the FIDIC 1999 Sub-Clause 17.6. the second result reduced the liability to 50% of the contract value, it was noted that this liability cap was indicated in 11.1% of the contracts all of which are by the same contractor and with diferent employers. This implies that this provision was requested by the contractor to reduce the risk. The third option limited the liability to 115% of the contract value, and was discovered in an infrastructre projects. However, other similar infrastructure project abided by the first option. The liability cap observed implemented a hybrid option which limited the contractors liability to 100% of the contract value & 150% in case of termination by default, this was discovered in a major electrical power plant project.

Dispute resolution:

Every contract should provide a mechanism to resolve disputes. While some tend to resolve to litigation at once, others tend to implement alternative dispute resolution techniques first that are less expensive, more efficient and less time consuming and can quickly resolve any disputes at an early stage. Whereas the customary litigation may be time consuming, the Egyptian law no. 27/1994 allows the parties to resolve to arbitration for commercial matters, if they agreed upon that in writing pursuant to article 12 of law no. 27/1994. Meanwhile, an arbitration clause is treated as an independent agreement even if it is part of the contract conditions and the nullity or termination of the contract does not affect the enforcement of this clause pursuant to article 23. Arbitration allows the parties to select their arbitral tribunal who are capable to understand the dispute and resolve it fairly and to agree on the time frame for the arbitration process, hence it can be quicker that customary litigation means.

1) It was noted that there are 4 alternative dispute resolution methods stated in the analyzed contracts and they were:

A. Parties to conduct a settlement Conference before resolving to arbitration.
B. Dispute Advisory Aboard, was elected in the beginning of the project.
C. The Engineer to conduct Sessions to fairly resolve the disputes.
D. A resolution panel to be created upon request to discuss a certain dispute.

The percentage of contracts that implemented these techniques were 27.8%, while the remaining projects lacked any alternative dispute resolution methods.

2) 94.4% of the contracts included arbitration clause, resolving the dispute to one of the arbitration centers. It was noted that the majority of the projects that opted to arbitration selected the arbitration seat to be in Cairo, the local country, at the Cairo reginal center for international commercial arbitration. While, only a few chose the seat of arbitration to be in France.
3) 88.9% of the projects stated that the arbitration decision shall be deemed final and binding to both parties which complies with the laws of Egypt.
4) To commence the arbitration proceedings, the parties must abide by the agreed duration before which parties can resolve to arbitration. The noted durations to commence arbitrations are one of the following:
    A. 28 days after submitting a notice of dispute.
    B. 30 days after submitting a notice of dispute and conducting amicable settlement sessions for 3 months.
    C. 56 days after submitting notice of dispute/dissatisfaction.
    D. After conducting a settlement conference and upon agreement to commence Arbitration.

4.2.7 Category 7: Termination & Force Majeure:

Finally, various circumstances may occur after the commencement of the project leading to termination. Many projects in 2011 & 2013 after the revolution has been suspended for extensive periods or terminated, similarly in 2016 after the devaluation of the currency, various contractors faced hardships to complete the projects. Thus, every contract includes provision to facilitate the termination process and indicate the events or circumstances that can allow the parties to terminate. This category analyses the events that can give rise to termination, in addition to analyzing the

force majeure events included in the contracts that entitles the contractor to extension of time and may terminate the project if the events are continuous. This category is divided to 4 sub-categories beginning with Employer's termination, Contractor's termination, the Consequence of termination and Force Majeure events.

Employer's Termination:

1) All the contracts analyzed allowed the contractor to terminate the contract if the employer faces liquidation issues. However, if the contractor is afraid that the employer's financial status is unstable and may jeopardize the continuity of the project, the Egyptian Civil Code Article no. 239 entitles the contractor to request the employer to demonstrate financial capability.

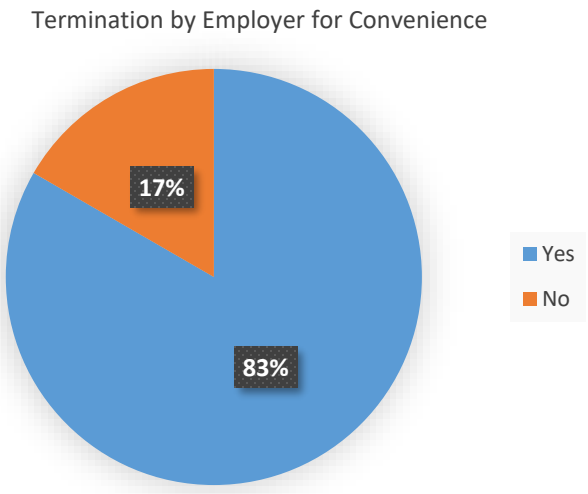


Figure 33: Termination for Convenience

2) 83.3% of the contracts included a provision to allow the employer to terminate the contract at its own convince any time during the project (figure 33). However, a prior notice of termination is required by law even if it was not stated in the contract pursuant to Article no. 218 & 219 of the Egyptian Civil Code. Meanwhile, the contractor shall be entitled to all expenses incurred for termination and the cost of all the works done plus the profit amount that he would have gained for the entire project as stated in article 663 Paragraph 1 of the Egyptian civil code.

3) 61.1% of the contracts had stated the employer's entitlement to terminate the contract if the contractor failed to submit the necessary insurances. Whereas the implementation of this provision shall be after the employer's issues a notice to the contractor to meet its obligation within a certain time frame. And if the contractor has failed to meet his obligation, then the employer can terminate the contract after issuing a notice of termination as stated in Article 650 paragraph 1 of the Egyptian civil code.

4) 55.56% of the contracts enabled the employer to terminate the contract if the contractor had reached the maximum limit for liquidated damages. While 11.1% of the contracts has lacked such a provision. According to the Egyptian Civil Code, if the contractor had not met his obligation within the necessary time frame and exhausted the maximum delay period with damages thus, article 650 of the Egyptian civil code entitles the employer to terminate and claim damages.

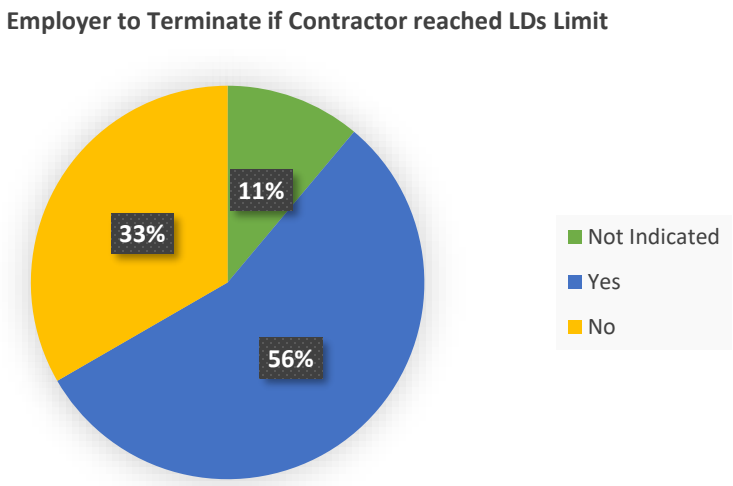


Figure 34: Termination Upon reaching LDs limit

5) All the contracts allowed the employer and contractor to request termination of the contracts if the works are suspended for an extensive period. The results should five different conditions mentioned in the contracts, while their percentage are shown in figure 35:

A. If works are prevented for 84 days or multiple periods totaling 140 days from notice of suspension
B. If works are prevented for 60 days continuous
C. If works are prevented for continuous period of 182 days
D. If works are prevented for Continuous period of 84 days
E. Upon Employer instructions

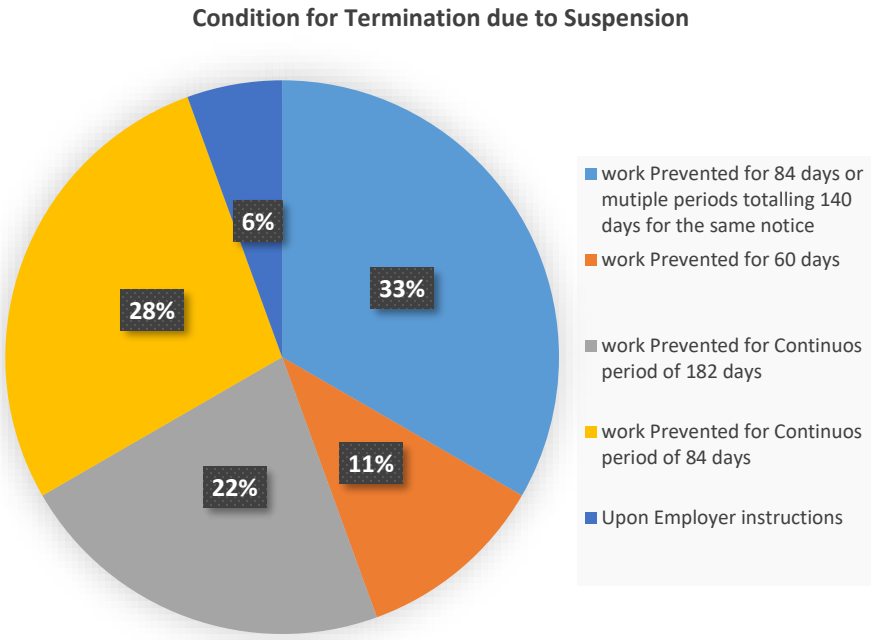


Figure 35: Termination Due to Suspension

The longer the duration, the more risk is borne by the contractor. As the contractor equipment's, material and labor remain idle, and the contractor is obliged to pay their costs until further notice. Meanwhile, the court can decide to reimburse the contractor for all the damages incurred plus profit depending on the reasons that lead to suspension.

Contractors Terminations:

Similarly, the contractor is entitled to terminate the contract if the employer did not meet his obligations i.e., if the employer is withholding payments without contractual basis. While some contracts allow the contractor to reduce the rate of progress or suspend the works if the payments are delayed, but what if this period had prolonged.

It was noted that 50% of the contracts analyzed included a provision to allow the contractor to terminate the contract if interim payments are delayed. While it was observed that this right is feasible after a delay period of more than 100 days. The remaining 50% of the contacts did not include a provision to allow termination and sufficed with the provision for interests for delayed payments.

Furthermore, as construction contracts are bilateral contracts the Egyptian civil code pursuant to article 161 allow the contractor to suspend the works if the employer did not meet his obligations while if the employer continues to withhold payments thus the contractor can request rescission of the contract and request damages subject to article 157 paragraphs 1 of the Egyptian civil code.

Consequences of Termination

1) 77.78% of the contracts denied the contractors ability to claim for loss of profit upon termination. While this provision may be nulled by court if the judges sees that the termination is due to events that outside of the contractor's control and that the damages caused are extensive pursuant to article no. 221 of the Egyptian civil code.

2) 77.78% of the contracts obliged the contractor to pay its subcontractors any amounts due in case of termination to avoid the sub-contractor claiming amounts from the employer directly as stated in article 662 paragraph 1 of the Egyptian civil code. While the court may reimburse the contractor for these amounts as part of the damages. Some contractors may opt to establish back-to-back contracts with their sub-contractors to split the risk between them in case the contractor did not get paid. The remaining contracts lacked this provision allowing the sub-contractors to resolve to court and claim the damages from the employer directly.

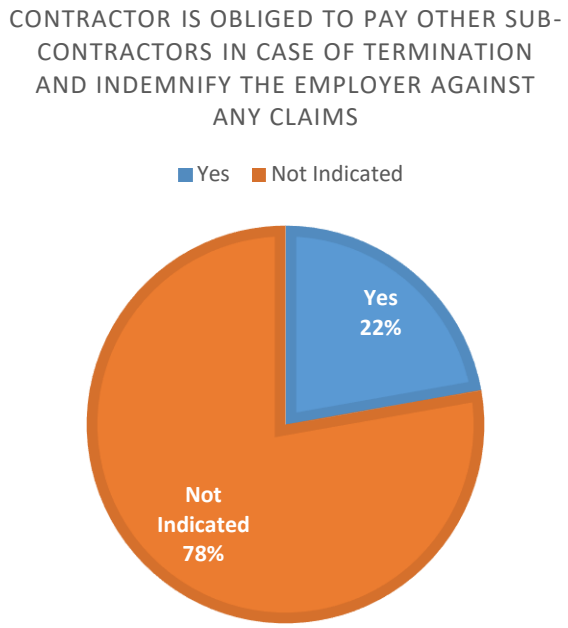


Figure 36: Contractor's obligation to pay Subcontractors upon termination.

Force Majeure:

This term is used to describe unforeseeable circumstances that can prevent the contractor and/or the employer from fulfilling their obligations. Article 147 of the Egyptian civil code which identified that the contract makes the law of the parties and can only be modified based on the agreement of the parties, defined in paragraph 2 force majeure events to be that of Exceptional and Unpredictable events of a general character, that makes the performance an obligation, without becoming impossible, becomes Excessively Onerous then the court may reduce the obligations to a reasonable limit. Meanwhile article 658 paragraph 4 have stated if the events have made the obligation entirely impossible because of exceptional circumstances that could not have been anticipated at the time of the contract then the laws allow the court to either modify the contract to restore the economic equilibrium or resend the contract. Furthermore, article 215 & 373 allowed the court to refute any damages for nonperformance of the contractor and the employer if the impossibility arose due to events outside of their control. Thus, if the contract did not include a force majeure clause, it is already provided by law.

In order to avoid disputes on whether an event fits these definitions and what is the entitlement of each party, all the contracts have included the main events that are considered force majeure events. The list below shows the findings of the events that give rise to force majeure.

1) 88.9% of the analyzed contracts have included Rebel, Wars, act of Terrorism, Riot and any disorder in the country that have direct influence on the continuation of the project as part of the force majeure events, that allows the contractor to claim for damages, extension of time or request recission of the contract if the circumstances justify. Whereas the remain contracts did not mention them as part of the list.

2) All the contracts had included whether conditions such as Rain, Sandstorm, tsunami, Floods, earthquake & fire as part of the Force Majeure events. While some employers have refuted rain from this list. However, the claiming party must justify that these weather conditions are of an exceptional nature that could not have been anticipated. This may require the weather conditions of Egypt from the past 10 years to demonstrate it.

3) All contracts included ionizing radiations, contamination by radioactivity and pressure waves as part of these events.

4) Finally, all contracts required the contractor to submit a notice of force majeure as soon as they are aware of the event. The notice period ranged from 7 days to 30 days. as seen in figure 37, with a mean value of 18.5 days and the most indicated value being 14 days as a sufficient amount of time to analyze the event and identify if the contractor can proceed or not.

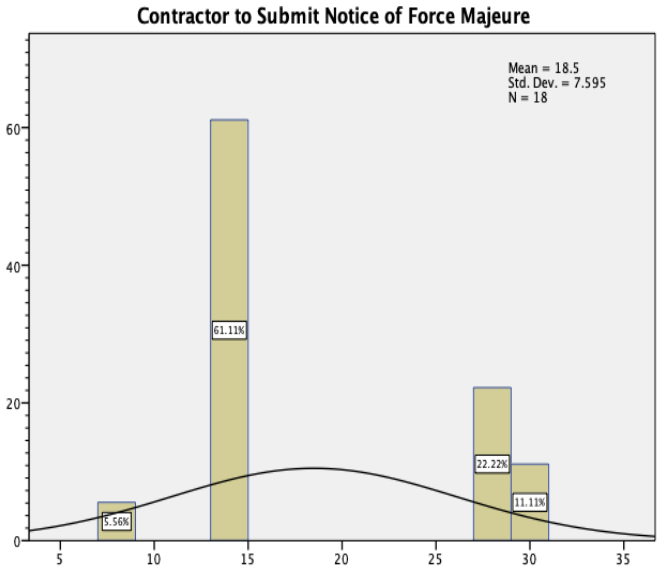


Figure 37: Results distribution for period to submit notice of Force Majeure.

To summarize, this chapter have examined the common contract conditions implemented in lump sum contracts in Egypt in the light of the findings of El Hotieby (2017) & the Egyptian Civil Code and revealed all the possible provisions that are implemented for better understanding and negotiation. However, as the contract terms cannot be divided, the next chapter shall discuss how the entire category can be evaluated by quantifying the risk balance in each category using a

web-based tool that assist in defining the risky provisions and in calculating the Contract balance index.

Chapter 5: Contract Balance Index:

In this chapter, the Contract balance index (CBI) is calculated to quantify the risk between the contractor and the employer incorporated within the contract terms and provisions. The contract terms are assessed on two stages to be able to determine the effectiveness of the entire contract. This first stage will address the contract provisions that are grouped in each category and compare them to each other. This stage shall assist in understanding the best combination of provisions in each category and reveal the strength and weakness of each category, and easily highlight the provisions that can be improved. The second stage aims to evaluate the entire contract using a linear programming technique (Data Envelope analysis). This technique assists in understanding how these overall contract terms are in favor of the Contractor, and to what extent can a contract be modified to be favorable to the Contractor.

5.1: Combined Analysis of Contract Balance Index

The first stage assesses the related contract terms together and compare the risk of this Category of provisions with the previously analyzed contracts, the contract balance index in this case can identify if these set of provisions impose greater or lower risk on the contractor compared to the previously analyzed contracts.

This assessment is done using a created web tool that incorporates all the previously indicated categories with all the gathered crucial provisions within each contract provision. A radar chart is created for each category of the classification, with every axis on the radar chart representing one of these provisions. The Axis are fixed for all contracts to standardize the Index. On each axis three radar charts are depicted, the highest risk and the lowest risk provision for each term and where is the newly entered contract provision is located within these.

Each combination of contract provisions will lead to a different form of the radar chart. The area of each radar chart is computed to signify the risk incorporated within each combination of provisions. For each contract seven radar charts are generated to analyze the seven categories of the contract. Equation 1 & 2 in chapter 3 are used to calculate the area of each radar chart.

In order to understand the significance of these areas, and to be able to resolve whether the Contract Balance Index of this category is acceptable or not, a datum line is required for each category from the previously gathered contracts to act as a measuring tool. This is created through reinserting all the discovered contracts provisions for each contract respectively in the web tool and recording their Contract Balance Index as demonstrated in table 20.

Rule of thumb: The lower the CBI value the higher the risk imposed on the contractor and the higher the CBI the more favorable are the conditions from a contractor's perspective.

The following sections discuss the analyses for the highest and lowest risk combination of provisions in each category using the created radar charts to further investigate the CBI and how this method can assist in analyzing the contract provisions.

Table 20: Risk Balance index for All contracts

	Category 1: Project Scope	Category 2: Financial Model	Category 3: Operations	Category 4: Claims & Variations	Category 5: Liquidated Damages & Extension of Time	Category 6: Limitation of Liability	Category 7: Terminations
C1	150.0	101.0	182.0	61.0	**45.0**	**26.0**	84.0
C2	175.0	81.0	142.0	30.0	21.0	24.0	90.0
C3	159.0	104.0	**118.0**	41.0	38.0	16.0	93.0
C4	164.0	92.0	153.0	**67.0**	22.0	17.0	79.0
C5	92.0	96.0	*147.0*	51.0	38.0	15.0	79.0
C6	140.0	75.0	123.0	50.0	36.0	20.0	86.0
C7	83.0	82.0	175.0	51.0	34.0	18.0	76.0
C8	142.0	108.0	139.0	62.0	26.0	**13.0**	84.0
C9	**180.0**	83.0	194.0	44.0	26.0	15.0	84.0
C10	141.0	108.0	190.0	39.0	20.0	**14.0**	79.0
C11	117.0	75.0	177.0	52.0	31.0	15.0	79.0
C12	82.0	108.0	**205.0**	52.0	22.0	15.0	**72.0**
C13	87.0	103.0	148.0	51.0	34.0	23.0	83.0
C14	**78.0**	112.0	192.0	55.0	24.0	15.0	**72.0**
C15	147.0	**68.0**	136.0	**33.0**	23.0	23.0	**103.0**
C16	85.0	89.0	176.0	54.0	**13.0**	15.0	**72.0**
C17	141.0	**116.0**	166.0	62.0	32.0	**13.0**	84.0
C18	127.0	93.0	184.0	39.0	23.0	15.0	**72.0**

5.1.1 Combined Analyses: Project Scope

Although both contracts had the same percentage for advance payment, performance bond and same retention percentage. Contract C9 indicated a CBI of 180, thus reflecting the lowest combination of risk within the project scope category. While contract C14 reflected the highest combination of risky provision within this category with a CBI of 78. Table 21 below shows the difference in provisions between these two contracts that lead to these risk factors. One of the major differences between these contracts was the contract currency, C9 was agreed with a foreign currency reducing the risk of devaluation on the contractor, while C14 had Egyptian currency. there were 13 provisions out of the 20 provisions in this category that lead to this variance in risk and leading to difference in radar charts.

Table 21: Provisions of Highest and lowest CBI contracts in Project Scope

Category	Sub	Code	Ref	Criteria	C9	C14
Project Scope:	**Contract Securities:**	**PS**	**PS1**	**Contract Currency:**	Dollar	EGP
			PS2	**Duration to Submit Performance Bond After Commencement**	-	7
			PS3	**Performance Bond Percentage**	10%	10%
			PS4	**Advance Payment percentage**	20%	20%
			PS5	**Specified date for Receiving Advance Payment.**	**N**	**Y**
			PS6	**Retention Percentages:**	5%	5%
			PS7	**Amortization of Advance Payment bond:**	1- by the amount repaid in Interim Payments	1- by the amount repaid in Interim Payments
	Contract Price Escalations:	**CPE**	**CPE1**	**Contract Price allows Escalation:**	**Y**	**N**
			CPE2	**Steel**	**Y**	**N**
			CPE3	**Cement**	**Y**	**N**
			CPE4	**Diesel**	**Y**	**N**
			CPE5	**Dollar**	**Y**	**N**
			CPE6	**Other E.g. Earth works**	**N**	**N**
	Language & Law:	**L**	**L1**	**Party Responsible for Costs associated in complying with authorities Rule & Regulation and others.**	**C**	**C**
			L2	**Adjustment for Changes in Legislations:**	**Y**	-
			L3	**Contractor to notify the PM with changes in Legislations:**	**Y**	-
			L4	**Contractor entitled To Profit & Overhead in case of Change in Legislations**	**N**	-

	Priority of documents	**PDs**	**PDs1**	**Contract defines Hierarchy of documents:**	**Y**	**N**
			PDs2	**Higher standard Document defined for Documents with same Priority (if applicable)**	**Y**	**N**
			PDs3	**Ambiguities in documents considered Variations:**	**Y**	**N**

Although Contract C9 had the currency in Dollars therefore it does not require an escalation, however it included provisions for escalation for Steel cement& diesel, reducing the risk of inflation of any of these items on the contractor. Whereas C14 lacked any escalation provision leading to higher risk borne starting from the tendering stage.

One of the major causes of risks associated with lump sum contracts is the hierarchy of documents. Contract C14 did not include a hierarchy of documents, nor did it define the higher standard of documents for documents with same priority. While C9 clearly indicated the hierarchy of documents thus reducing the risk of disputes and providing the contractor with the higher document to abide by. Meanwhile, if the employer opts to abide by another document the contractor is entitled to additional cost and time.

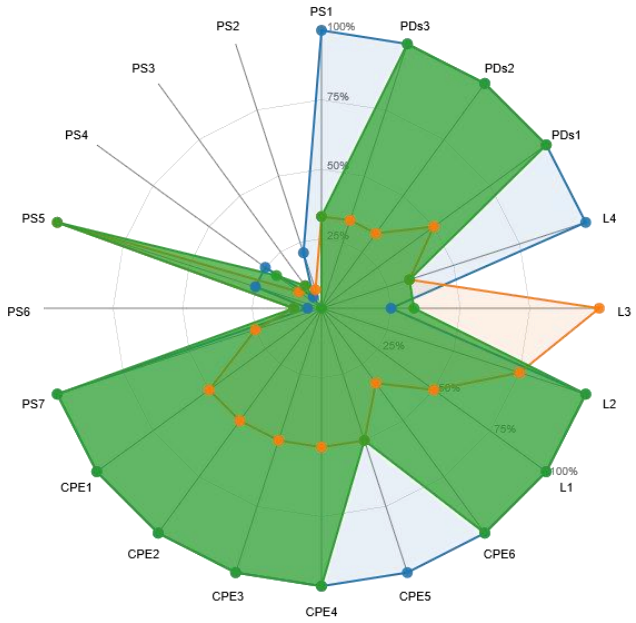


Figure 38: Radar chart of C9

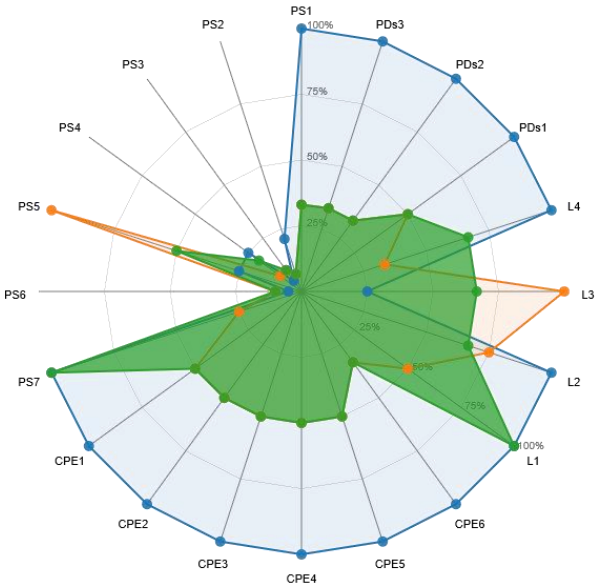


Figure 39: Radar Chart of C14

Finally, in the Language and law sub-category, Contract C9 allowed the contractor to receive monetary adjustments for changes in legislation that occur after the tendering stage and has effect on the contractor price. While obliging the contractor to notify the employer with such changes. Whereas C14 did not mention what are the procedures to be applied in case of any changes in legislation, and thus this can raise disputes during the project.

The radar charts figure 38 & 39 shows how these provisions lead to different variations and the areas of each of these contracts. The Blue dots indicated shows the most favorable condition (lowest risk) to the contractor, and the orange dots shows the highest risk conditions to the contractor while the Green dots are the specific provisions of the contract being studied. C9 clearly shows a higher area with more provisions on the verge of the lower risk. While C14 shows most of the provisions closer to the center leading to a higher risk factor.

5.1.2 Combined Analyses: Financial Model:

Contract C17 indicated a CBI of 116 reflecting the lowest combination of risk against contract C15 that indicated a CBI of 68 with the highest combination of risky provision within the analyzed contracts. Table 22 below shows the provisions of both contracts that lead to these risk factors. Once again, the provisions with the lowest risk are further from the center indicated with the blue dot, and the highest risk provisions are closer to the center indicated with the orange dots on the radar charts below.

Table 22:Comparision between provisions in Financial Model

Category	Sub	Code	Ref	Criteria	C15	C17
Financial Model:	**Interim Payments:**	**IPC**	**IPC1**	**Interim Payments Submission Intervals:**	1- every 30 Days	1- every 30 Days
			IPC2	**Conditions for Submission of Interim Payments**	**N**	1- Value of Works exceeds 90% of Approved Work in Place Histogram otherwise If not Approved Yet 80% of the preliminary work in Place.
			IPC3	**Percentage for material on Site retrieved:**	2- 75% of Material invoice	2- 75% of Material invoice
			IPC4	**Percentage obtained for Architecture and MEP works delivered with WIR:**	1- Percentages agreed upon in the Contract	3 40% of BOQ for architecture works and 50% of BOQ for MEP works

			IPC5	**Review Period of IPC by Supervision Consultant**	20 days	20 days
			IPC6	**Review Period of IPC by PM**	-	20 days
			IPC7	**Period for Employer to Issue Payment**	30 Days	10 days
			IPC8	**consequences of the contractor's failure to provide all supporting documents:**	1- Employer to withhold 15% of IPC	3- Employer to withhold 25% of IPC
			IPC9	**Contractor Ability to Object on Issued Payment**	**Y**	**N**
			IPC10	**Contractor entitled to Monies for partial completed work not inspected by Supervision consultant**	**N**	**Y**
	Delayed IPC Payments	**DP**	**DP1**	**Contractor is entitled to reduce rate of progress if IPC is delayed: From Submission of notice of delay**	3- 21 DAYS	1- 30 days
			DP2	**Contractor entitled to EOT if IPC is delayed**	**N**	**Y**
			DP3	**Contractor is Entitled to Interest For delayed Payments**	**N**	**Y**
	Final Certificate:	**FC**	**FC1**	**Submission of Final Certificate: From receiving Performance Certificate**	2 -56 Days after receiving the performance certificate	2 -56 Days after receiving the performance certificate
			FC2	**Review Period of final certificate by PM**	42 days	30 days

In both contracts, the contractor could apply for the interim payment every month with the same total duration of 50 days for review by the supervision consultant ant the employer and was entitled to the same monetary percentage for material site. However, the main differences appear in 9 provisions as follows:

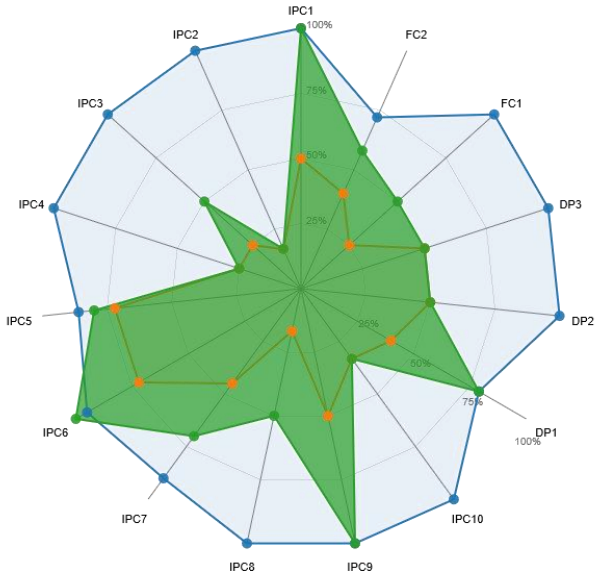


Figure 40: Radar chart of C15

1) C15 showed a lower risk by not having a restricting condition to achieve before applying for interim payment as opposed to C17.
2) C15 entitled the Employer to retain 15% of the interim payment if the contractor did not submit all the required documents,

while c17 allowed the employer a higher percentage of 25% increasing the risk on the contractor.

3) Meanwhile, C15 allowed the contractor to object on any issued payments if he considers it to be unfair for re assessment. While c17 enforced the contractor to abide by the issued interim payment.
4) Contract c17 entitled the contractor to receive partial payments for works that are not yet inspected by the Supervision Consultant, this is beneficial for the cashflow of the project and reduces the risk on the contractor tremendously.

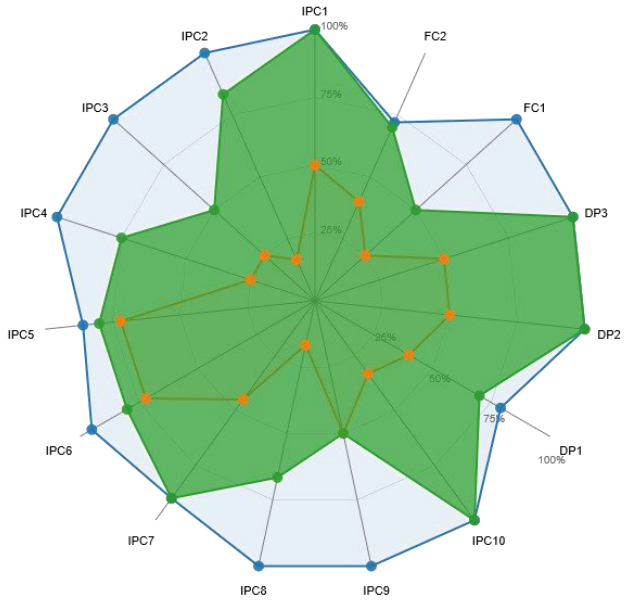


Figure 41: Radar chart of C17

5) In case of any delayed payments from the employer, both contracts allowed the contractor to reduce the rate of progress however unlike C17, C15 did not entitle the contractor to any extension of time or even to get interest as a result of this delay.
6) Finally, Contract C17 indicated a lower period of 30 days for the review of final certificate providing the contractor with his monies earlier than C15, thus aiding in minimizing the risk of this category on the contractor.

The Radar chart of contract C17 Figure 41 covers a larger area compared to the Radar chart extracted for Contract C15, figure 40. C17 chart shows a wider spread of provision towards the lower risk, while C15 has some low-risk provision, but with the majority closer to the center, making the overall combined analysis for this category bear a higher risk on the contractor.

5.1.3 Combined Analyses: Operations

This category includes provisions that describes the running operations of the project. Every contractor should assess these provisions from his perspective depending on the project type, size, location and the reputation of the contractor and the employer. Contract C12 had the

most favorable conditions for the contractor with a CBI of 205, while contract C3 indicated the severest conditions in this category with a CBI of 118. Table 23 shows the provisions of each contract and figures 42 & 43 depict the radar charts for each of these contracts.

Table 23: Provisions of Highest and Lowest CBI in Operations

Category	Sub	Code	Ref	Criteria	C3	C12
Operations:	**Commencement of Works:**	**CD**	**CD1**	**Specified Commencement date:**	**Y**	**Y**
			CD2	**Duration to Commence Works: From Commencement Date**	14 days	7 DAYS
			CD3	**Collection of Advance Payment to be condition Precedent for Commencement**	-	**N**
			CD4	**Receiving Site Possession to be Condition Precedent for Commencement:**	**Y**	-
	Program of works/revised program	**PWs**	**PWs1**	**Period to Submit Program by Contractor form Commencement date**	21 days	14 DAYS
			PWs2	**Review Period by Engineer from Contractor's Submission:**	21 days	-
			PWs3	**period for Re-Submission of rejected Program: From Notice of Non-Compliance**	7 days	-
			PWs4	**Consequences of failing to submit / obtain approval to program.**	2- Employer entitled to retain 5% of IPC until Approval	7- ENGINEER TO DETERINE THE VALUE OF WORKS DONE AND ANY DEDUCTION NESSECARY
	Take Over Certificate:	**TOC**	**TOC1**	**Completion of tests Condition Precedent to Taking Over**	**Y**	**Y**
			TOC2	**Submission of As Built drawings, Manuals & operations etc. Condition Precedent**	**Y**	**N**
			TOC3	**Contractor is responsible for the care of the works that may be used by the Employer Before TOC**	**N**	**N**
			TOC4	**In Case of Taking over of Portion of works % of Retention returned**	2- 100%	3- 0%
	Contractors Duties:	**CO**	**CO1**	**Contractor's duty to Confidentiality after Termination or Taking over**	**N**	**Y**
			CO2	**Contractor requirement to Inherent Defects after Termination**	**Y**	**N**
			CO3	**Contractor to Submit Breakdown for BOQ items After Commencement: (Usually within 14 to 28 days)**	**Y**	**Y**

	Insurance	**Ins**	**Ins1**	**employer entitled for notice from the insurers prior to changes of coverage or failure to renew policies**	**N**	**Y**
			Ins2	**contractor to obtain a waiver by insurance companies of all rights of subrogation they might be able to exercise against the Employer or its representatives.**	**N**	**Y**
			Ins3	**Require the contractor to insure against loss or damage to the plant prior to its delivery and during its unloading to site.**	**N**	**Y**
			Ins4	**Indemnify the employer against all losses and claims arising from the contractor's failure to comply by the conditions related to insurance policies.**	**N**	**Y**

The main difference that leads to contract C12 to have the higher CBI than C3 were:

1) In case of not obtaining approval to the program of works, C12 had the engineer to determine the value of works done and assess the progress of works without having to withhold any amounts until obtaining the approval.
2) C12 did not require the contractor to submit the as-built drawings, operation manuals etc. prior to the issuance of the taking over certificate, thus easing the process of handing over on the contractor.
3) C12 did not require the contractor to inherent any defects after termination.
4) Finally, C12 had required the contractor to maintain insurances that protects both the employer and contractor from any liabilities.

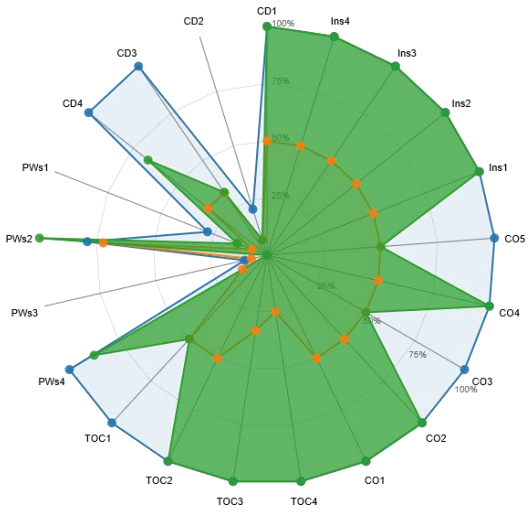


Figure 42: Radar chart of C12

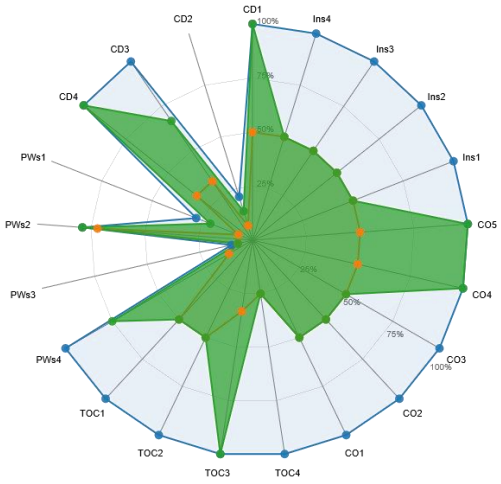


Figure 43: Radar chart of C3

5.1.4 Combined Analyses: Claims & Variations

This category is important as it presents 13 provisions related to the analysis of claims and variation, this category was stated as one of the main causes of disputes in construction projects. Contract C4 indicated a CBI of 67 demonstrating the lowest combination of risk within this category while contract C15 revealed the highest combination of risk provisions in claims and variations with a CBI of 33. Table 24 shows the 13 provisions in this category that lead to this variance in risk, while they are as follows:

Table 24:Contract provisions of Claims & Variations

Category	Sub	Code	Ref	Criteria	C4	C15
Claims & Variations:	**Claims:**	**CLm**	**CLm1**	**Period to submit notice of claim**	28 days	14 days
			CLm2	**Period to submit claim Particulars: From notice of Submission Date**	14 days	-
			CLm3	**Lowest Claim Value Provision: * Hint (its observed that some Contractors state a value of 50,000EGP minimum Claim value)**	**N**	**N**
	Variations:	**VR**	**VR1**	**% of Allowed Variations from (Contract Price Vs BOQ Items)**	1- Contract Price	2- BOQ Items
			VR2	**% of Allowed Variations from Contract Price Items:**	1- 25% of Contract Price	-
			VR3	**% of Allowed Variations from BOQ Items:**	-	2- BOQ Item varies more than 25 %
			VR4	**Contractor is obliged to proceed with instructed variations prior to price agreement:**	**Y**	**Y**
			VR5	**Duration to Submit Notice of variation:**	28 Days	28days
			VR6	**% of overhead and profit to be used for evaluation purposes.**	25%	15%
			VR8	**Variations Valuation options: 1) If it is an Item in the BOQ, Use Similar Item.**	**Y**	**Y**
			VR9	**Variations Valuation options: 2) If there is a similar Item, Use It as basis of evaluation**	-	**Y**
			VR10	**Variations Valuation options: 3) If New Item:**	-	**2- Engineer to determine a reasonable amount**
			VR11	**Value Engineering Benefit: Contractors Entitlement from Cost reduction:**	25%	25%

1) for the claim's provisions, C15 had a much lower time for the contractor to submit the notice to claim, putting the contractor at a higher risk of losing the entitlement to claim due to not abiding by the time bar requirement of this provisions.
2) C15 did not have any period stated to submit claim particulars or interim claim, leaving it to the assessment of the Engineer, that may cause disputes if the parties do not agree on it.
3) In case of Variations, C15 had the variations calculated as a percentage deviation from each BOQ item, which is a more favorable case for the contractor compared to having it calculated from the entire Contract value as stated in C4.

   However, C15 allowed each BOQ item to vary 25% which was the highest stated percentage before the contractor can renegotiate any prices.

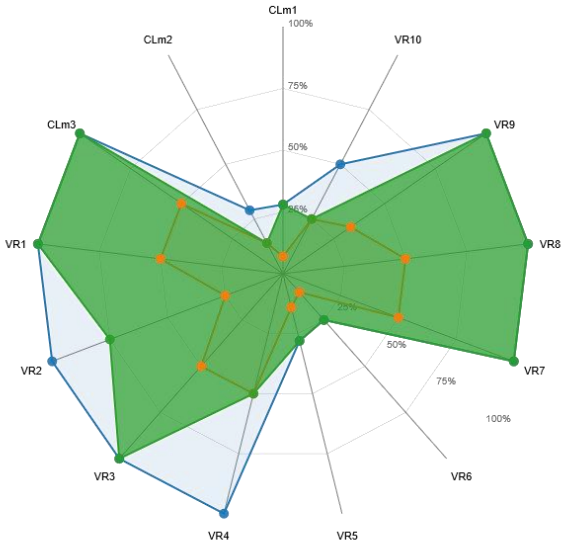


Figure 44: Radar chart of C4

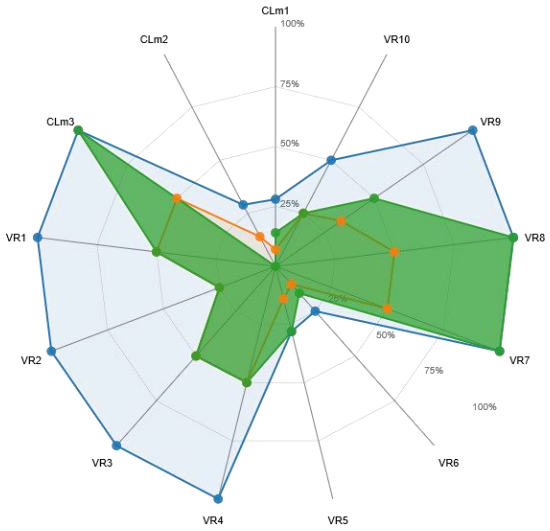


Figure 45: Radar chart of C15

4) C15 entitled the contractor to 15% profit and overheads in assessing variations which was one of the lowest percentages identified. Meanwhile, C4 allowed the contractor to 25% which was the highest percentage for profits and overheads assigned to the contractor.
5) C15 had all three stages of the evaluation of variations indicated making it clear for both parties, while C4 only mentioned the most obvious option which is if an item is stated in the BOQ, then the same prices to be used. Several disputes may arise if the parties do not agree on the assessment methods.

6) Both contracts had the same percentage of contractor entitlement from the cost reduction for any value engineering conducted.

5.1.5 Combined Analyses: Liquidated damages and Extension of Time

To assess the extension of time provisions and the liquidated damages provisions and evaluate whether these conditions are harsh compared to other projects in Egypt they should be considered together. In this category, contract C1 demonstrated the lowest combination of risk for Extension of time and liquidated damages provisions with a CBI of 45, whereas C16 showed the strictest combination of provisions with a CBI of 13 as demonstrated in the radar charts figures 46 & 47. Table 25 shows the 9 main provisions examined in this category, out of these, 6 main difference led to the variation between these contracts.

Table 25: Provisions of liquidated damages and Extension of Time category

Category	Sub	Code	Ref	Criteria	C1	C16
EOT & LD's	**Extension of Time**	**EOT**	**EOT1**	**Can engineer consider any omitted works in EOT**	**Y**	**Conditional YES - Shall Not Decrease any granted EOT**
			EOT2	**Availability of Grace Period**	**Y**	**N**
			EOT3	**Contractor to Claim EOT for Insufficiency of design Drawings or documents supplied by Employer**	**Y**	**N**
	Intermediate milestone available	**MLs**	**MLs1**	**Presence of Intermediate Milestones:**	**Y**	**Y**
			MLs2	**Penalty**	1- 25000EGP per day	**N**
			MLs3	**Penalty is Recoverable: * Hint**	**Y**	**N**
	Liquidated Damages	**Lds**	**LDs1**	**Max LDs applied *Excluding Gross Negligence**	1-10% of contract value or section of the works	1-10% of contract value or section of the works
			LDs2	**Application of LDs:**	1- 1% per week for 10 weeks	**4- 2% of contract price for every week delay.**
			LDs3	**Employer to deduct monies from the contractor without prior notice:**	**Y**	**Y**

1) C16 did not include any grace period, while C1 had a four-month grace period for the contractor to complete his works without being penalized.

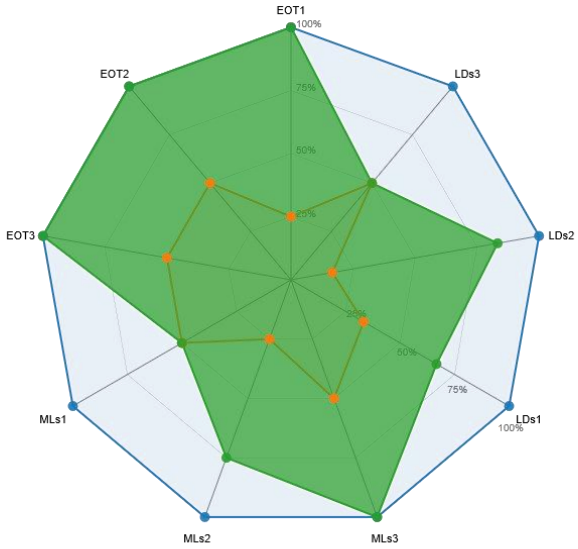


Figure 46: Radar chart of C1

2) In several Lump Sum projects, the design documents may not be comprehensive enough, requiring the contractor to exhaust some of the project duration in clarifying issues with the engineer through submitting requests for information, whereas the employer may be delayed in providing the required clarification, thus entitling the contractor to extension of time. C1 entitled the contractor to extension of time for this delay reducing the risk on the contractor.

3) In Assessing the Extension of time claim, C16 was more lenient in allowing the engineer to consider any omitted works however the engineer cannot reduce any time previously granted. While C1 allowed to the Engineer to reduce any granted extension of time.

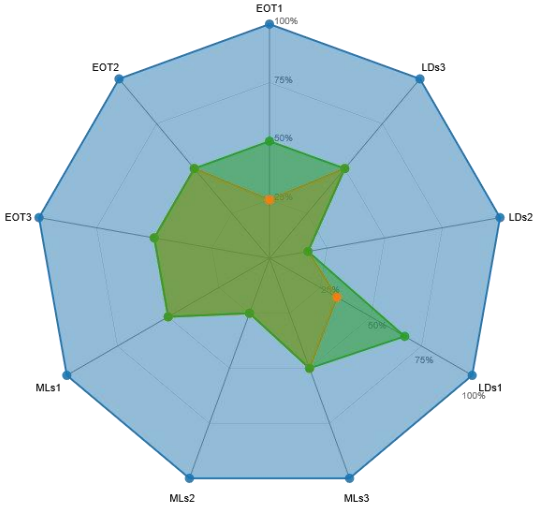


Figure 47: Radar Chart of C16

4) In the Intermediate Milestone Sub-category, both contracts had intermediate milestones as an obligation for the contractor. However, C1 had a penalty imposed on the contractor in case of not achieving the intermediate milestone which adds additional burden on the contractor. Although the penalty is recoverable upon completing it and reaching the next milestone on time but the enforcement of penalties under the Egyptian civil law may not be acceptable. Thus, C16 has more favorable conditions in this aspect.

5) Finally, both contracts had the same liquidated damages cap of 10% but had different means of application, C16 had the most stringent options by deducted 2% of the contract value for the section

of works allowing the contractor a maximum of 5 weeks. This vastly increases the risk on the contractor. While C1 allowed the contractor a 10-week duration and included a grace period provision that tremendously reduced the risk on the contractor.

5.1.6 Combined Analyses: Limitation of Liability

This category assesses the limitation of liability provisions and the procedures for dispute resolution stated in the contracts. Contracts C8 & C17 reflected the highest risk combination of provisions with a CBI of 13 furthermore, C10 recorded a CBI of 14 due to some slight variations. Meanwhile, Contract C1 showed the most favorable combination of provision with a CBI of 26. Table 26 below shows the different provisions that were stated in each contract.

Table 26: Provisions of Limitation of Liability and Dispute resolution

Category	Sub	Code	Ref	Criteria	C10	C8 & C17	C1
Limitation of Liability & Dispute Resolution	**Limitation of Liability**	**LL**	**LL1**	**Limitation of Liability Provision**	**Y**	**N**	**Y**
			LL2	**Contractor Liability**	1- 100% of the contract value (except in case of fraud and gross negligence)	**N**	1- 50% of the contract value (except in case of fraud and gross negligence)
	Dispute Resolution	**DR**	**DR1**	**Presence of Alternative Dispute resolution method before Litigation/Arbitration:**	**N**	**N**	**Y**
			DR2	**Arbitration**	**N**	**Y**	**Y**
			DR3	**Award by Arbitrators deemed Final and Binding by court**	**N**	**Y**	**Y**
			DR4	**Duration To commence with arbitration from dispute date**	**N**	4 months (3MONTH AMICABLE SETTLEMENT AND ONE MONTH NOTICE)	30 days

In contract C10 there was a limitation of liability provisions stated as a cap for the contractor with the maximum liability equivalent to 100% of the project value. However, the contract lacked any alternative dispute resolution procedure to attempt to resolve claims early on.

In addition, the contract did not resolve the disputes to arbitration instead it opted to the normal litigation process, which is time consuming and puts the contractor at a higher risk.

Similarly, Contracts 14 & 17 indicated the same CBI because they did not include any limitation of liability provision nor having any alternative dispute resolution method. However, these contracts included an arbitration agreement and deemed the arbitration award to be final and binding by all parties that made it more favorable to the contractor. Although the contracts allowed arbitration to commence after allowing a 3-month period to conduct settlement meetings.

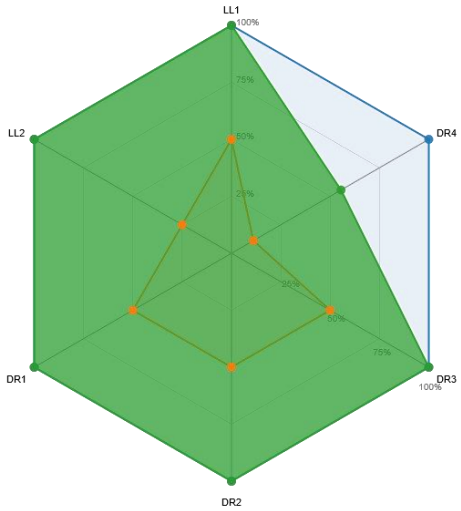


Figure 48: Radar Chart of C1

Finally, C1 included a Limitation of liability provision with a maximum contractor liability of 50% of the contract value, thus reducing the risk on the contractor tremendously. In addition to having an alternative dispute resolution technique to be implemented during the project to resolve any issues. While if the parties could not reach a solution, the contract included an arbitration provision that allows the parties to resolve to arbitration after giving a 30 days' notice period only.

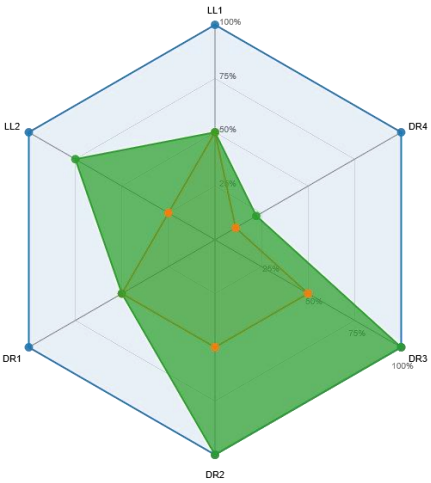


Figure 50: C8 & C17 Radar chart

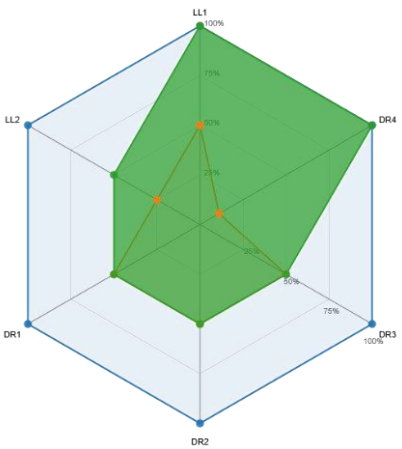


Figure 49: C10 Radar Chart

5.1.7 Combined Analyses: Termination & Force Majeure

Finally, this category presents the conditions for termination from the employer, contractor or due to outside forces by reviewing 12 main provisions. Some contracts have given the Employer the authority to terminate for several reasons which puts the contractor at risk, a proper balance of authority and clear definition of rights and obligations of each party and what is the contractor entitled to in case of termination is the goal of this category. Contract C4 indicated a CBI of 103 demonstrating the lowest combination of risk provisions within this category while contracts C12, C14, C16, C18 revealed the highest combination of risk provisions with very slight modifications with a CBI of 72. Table 27 shows the provisions of each of these contracts while the radar charts below show the different forms discovered for each contract.

Table 27: Highest and Lowest Provisions for Termination & Force Majeure

Category	Sub	Code	Ref	Criteria	C12	C14	C16	C18	C15
Termination & Force Majeure	Employer Termination:	Tre	TRe1	Termination by Employer for convenience	Y	Y	Y	Y	N
			TRe2	Termination in case Contractor did not submit Insurances	Y	Y	Y	Y	NA
			TRe3	Termination due to liquidation of Employer	Y	Y	Y	Y	Y
			TRe4	Employer to Terminate if contractor reached LDs limit	-	N	N	Y	N
			TRe5	Condition For Termination due to Suspension	4- work Prevented for Continuos period of 84 days	4- work Prevented for Continuos period of 84 days	4- work Prevented for Continuos period of 84 days	3- work Prevented for Continuos period of 182 days	1- work Prevented for 84 days or mutiple periods
	Contractor'sTerminations:	TRc	TRc1	Contractor To terminate if the employer did not issue interim payment within the agreed duration and without contractual basis *It was observed that the Employers right to terminate becomes valid after more than 100 days	N	N	N	N	Y
	Consequences of Terminations:	CTR	CTR1	contractor is obligated to pay to other Subcontractor any amounts payable in case of termination and indemnify the Employer against claims	Y	Y	Y	Y	NA
			CTR2	Contractor ability to claim for loss of profit for termination	N	N	Y	N	N
	Force Majeure	FM	FM1	Termination due to Force majeure	Y	Y	Y Clause 19.1	Y	Y
			FM2	Inclusions of Force Majueure Events: (Rebell, War, Terriorsim, Riot, Disorder in the country, Radioactive radiations or neucluar waste, Invasion, Revolution,)	Y	Y	Y	Y	Y
			FM3	Country retaled events (war- riot-terrorisim- rebell- Invasion- revoloution)	Y	Y	N	Y	Y
			FM4	Weaher Conditions(Rain- Sandstorm- tsunamy - Floods- earthquake- fire etc) * it was observed that some developers in Egypt exclude any quantities of rain	Y	Y	Y	Y	Y
			FM5	Contractor to Submit Notice of Force Majeure: From Becoming aware of the incident	28 DAYS	28 DAYS	14 DAYS	28 DAYS	14 DAYS

C15 revealed the optimum provisions for the contractor, as it did not include a provision to allow the Employer to terminate at any period of time for his convenience. Plus, it did not allow the Employer to terminate the contract if the insurance documents are not complete. Instead, the contract required the employer to submit notices and withhold certain amounts until the required documented are submitted. Moreover, C15 is the only contract that included a provision to allow the contractor to terminate if the Employer did not meet his obligations, which is stated in the Egyptian Civil Law, while the other contracts refrained from stating this right in the contract. Meanwhile Other contracts for Employer termination had almost the same provisions that entitled the employer to terminate for convenience & if the contractor did not submit the necessary insurances & in case the contractor reached the LDs limit.

Although, almost all the contracts had the same provision for Force Majeure indicated, slight variation was stated in C16 that did not allow country related events such as, war or riots to be considered as force majeure. This contract was signed after the 2013 revolution, thus with 2 previous incidents the employer might have opted to protect his interest and restrict the contractor from requesting termination by removing this provision.

Whereas, for Consequences of termination all contracts except for C15 clearly stated the contractor's obligation to pay his sub-contractors upon termination and that they cannot request any monies due from the Employer. While C15 did not include this provision and left it to be subject to the laws of Egypt. Meanwhile, C16 was the only contract that allowed the contractor to claim for lost profit in case of termination, other contracts clearly stated that the contractor cannot claim for any profits or lost opportunities due to termination.

Finally, the radar chart of contracts C12 & C18 are almost the same shape as the provisions are similar. C16 had some variation leading to a different form, however the CBI calculated was the same. Contract C15 had the highest area with the most lenient provisions balancing the authority between the contractor and the employer.

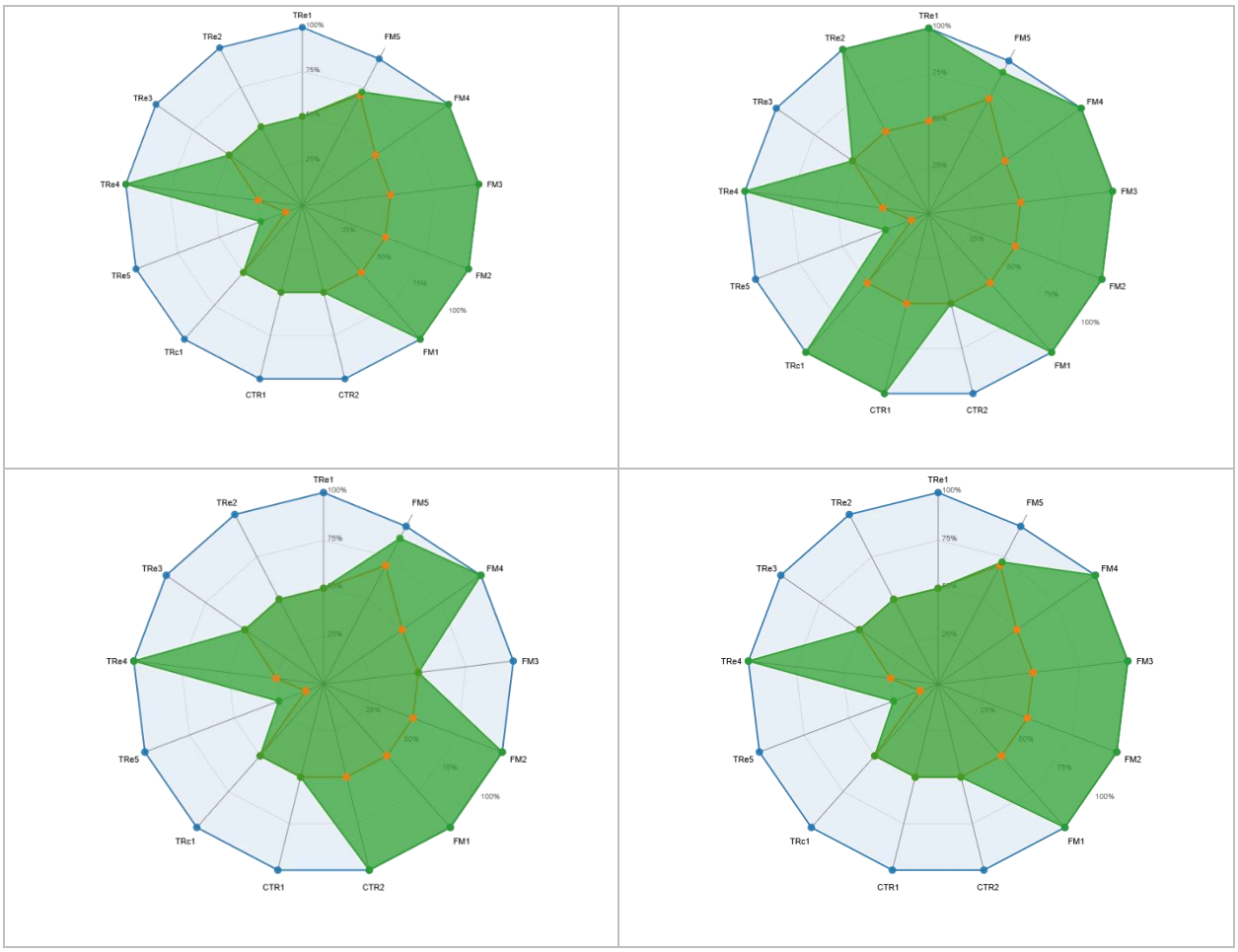


Table 28: Radar charts for Highest and Lowest CBIs in Termination

To conclude, this stage addressed the main critical provisions as gathered from literature and from the previous projects in Egypt and compared their results together and demonstrated how the radar chart can be used to assess and evaluate the contract terms related to the same category. This enables to identify the provisions that can be modified to balance the risk between the Contractor and the Employer. However, the contract terms and conditions should be read as whole and cannot be divided from each other.

5.2 Data envelope analysis in Contract Evaluation:

In the second stage of this research, a new technique is presented to analyze the Contracts as a whole and identify how favorable the contract terms are to either party. In this research, the contract terms are analyzed from the perspective of the Contractor, being the non-drafting party. As stated in Chapter 3, Data envelope analysis which is a linear programming technique is a nonparametric frontier estimation methodology for measuring relative efficiencies and performance of a collection of related comparable entities (DMUs). In this case, the DMUs are the results of the Contract Balance Index computed in the previous stage for each Category of the 18 contracts. The first two cases presented below depicts how this technique can be used to compare 2 categories from each contract together, by using the RBI of these categories as the DMUs, and applying the necessary constrains. While the third case will examine how the entire contract is evaluated.

for all cases, upon modifying the DMUs in any category, a new hypothetical contract will be plotted on the graph. Accordingly, this hypothetical contract may modify the shape of the convex hull. If the new hypothetical contract provisions, are similar to those identified in the analyzed contracts, then the hypothetical contract will be plotted within the boundaries of the convex hull. And the Data envelope analysis will identify if these contract provisions are favorable to the contractor compared to the previously analyzed contracts. i.e., it will reveal the degree of improvement that can be made to the contract provisions to be more favorable to the contractor in Egypt.

Meanwhile, if the new hypothetical contract contains a combined set of provisions that are not covered in our analysis and are more favorable to the contractor, then this newly plotted contract will modify the shape of the convex hull to incorporate this contract. This will make other previous contracts seem less attractive to the contractor. In other words, the frontier plotted for the analysis is dynamic and shall be modified based on the inputs of the new contracts and of the database created. Moreover, this process is adaptive to new conditions and can evaluate the contracts in a more realistic approach, as its obvious that new projects will have contract terms that are tailored to the project and to the macro and microenvironments affecting the project.

The methodological framework for the implementation of the Data envelope analysis is presented in Chapter 3 as follows:

1) Determine the weights for each operating unit, that can be used to decide the inputs for the composite operating unit.
2) Enforce a constraint that requires the weights to sum-up to 1.
3) Require the output measure of the composite operating unit to be greater than or equal to the corresponding output for the respective operating unit.
4) Define a decision variable, E, which determines the fraction of the operating unit's input available to the composite operating unit.
5) For each input measure, write a constraint that requires the input for the composite operating unit to be less than or equal to the inputs available.
6) State the objective function as Max E.

The result of the DEA efficiency for all cases is based on the optimal objective function value for E. The decision rule is as follows:

7) If E= 1, then the composite contract (Contract in question) incorporates the optimum conditions for the Contractor, hence it is located on the frontier of the gathered contracts.
8) If E >1, then the composite contract is less efficient, thus the composite contract incorporates more risky provisions on the contracts making it less favorable to the contractor. While the degree of contract improvement that can be achieved is the percentage over the value of 1.

5.2.1 Case 1: Category 1 Project Scope (PS) Vs Category 2 Financial Model (FM)

To further elaborate how this technique is implemented, two Contracts categories from each contract are compared together. Category 1 is composed of 20 contract provisions and category 2 is composed of 15 contract provisions. The Contract Balance Index calculated in the previous stage is utilized as seen in table 29.

For each of the two inputs, the sum of the RBI of each contract is multiplied by its respective weights as demonstrated in the equation below:

$$\text{Eq (3)} = \sum [(\text{PS of C1} \times \text{Weight}) + (\text{PS of C2} \times \text{Weight}) + (\text{PS of C3} \times \text{Weight}) + \ldots (\text{PS of C18} \times \text{Weight})]$$

$$\text{Eq (4)} = \sum [(\text{FM of C1} \times \text{Weight}) + (\text{FM of C2} \times \text{Weight}) + (\text{FM of C3} \times \text{Weight}) + \ldots (\text{FM of C18} \times \text{Weight})]$$

While the constrains imposed in this model are as follows:

- Constrain 1: For Category 1: (CBI of PS × E value) ≤ Eq (1)
- Constrain 2: For Category 2: (CBI of FM × E value) ≤ Eq (2)
- Constrain 3: WC1 + WC2 + WC3+……..+ WC18 = 1

As we are computing the maximum value of E there should be a limit to ensure the modified point is not outside of the convex hull, hence the modified point coordinates should be less than or equal to Constrain 1 and 2. The model was created using Microsoft Excel Solver, and implemented these constrains. In order to show how this model works, Contract C9 is inserted as the Contract to be analyzed, and the E value is determined. A graph is plotted on Figure 51 to show the convex hull and graphically depict the performance of C9.

On this figure, each contact is plotted on the graph with Category 1: Project Scope is plotted on the X axis and Category 2: Financial Model, is plotted on the Y axis. Points on the periphery are connected to show the convex hull.

As stated in our rule before the lower the CBI value the higher the risk imposed on the contractor and the higher the CBI the more favorable are the conditions from a contractor's perspective. Hence, the most favorable contracts to the contractor are the ones on the top right quarter i.e., contracts C14, C17, C3 & C4.

Contract No.	Category 1: Project Scope	Category 2: Financial Model	Weights
C1	150.0	101.0	0
C2	126.0	81.0	0
C3	159.0	104.0	0.41507431
C4	**164.0**	92.0	0
C5	92.0	96.0	0
C6	140.0	75.0	0
C7	83.0	82.0	0
C8	142.0	108.0	0
C9	111.0	83.0	0
C10	141.0	108.0	0
C11	117.0	75.0	0
C12	82.0	108.0	0
C13	87.0	103.0	0
C14	**78.0**	112.0	0
C15	87.0	**68.0**	0
C16	85.0	89.0	0
C17	141.0	**116.0**	0.58492569
C18	127.0	93.0	0
		E	**1.337579618**

Conditions			
Constraints	**Constraint 1**	**Constraint 2**	**Constraint 3**
	148.4713376	111.0191083	1
Modified Point	**148.4713376**	**111.0191083**	1
Contract Analyzed	**111.0**	**83.0**	

Table 29: Case 1 -Data Envelope analysis C9

Contract C9 is in the lower part of the graph Scoring 111 in Project Scope and 83 in the Financial model. Upon implementing our evaluation technique and using solver to compute the weights. It revealed that C9 has an E value of 1.3375 i.e., C9 is below the convex hull and has a 33.75% ability to be modified to be favorable to the Contractor. The green dot shows the modified location of C9 after the modification.

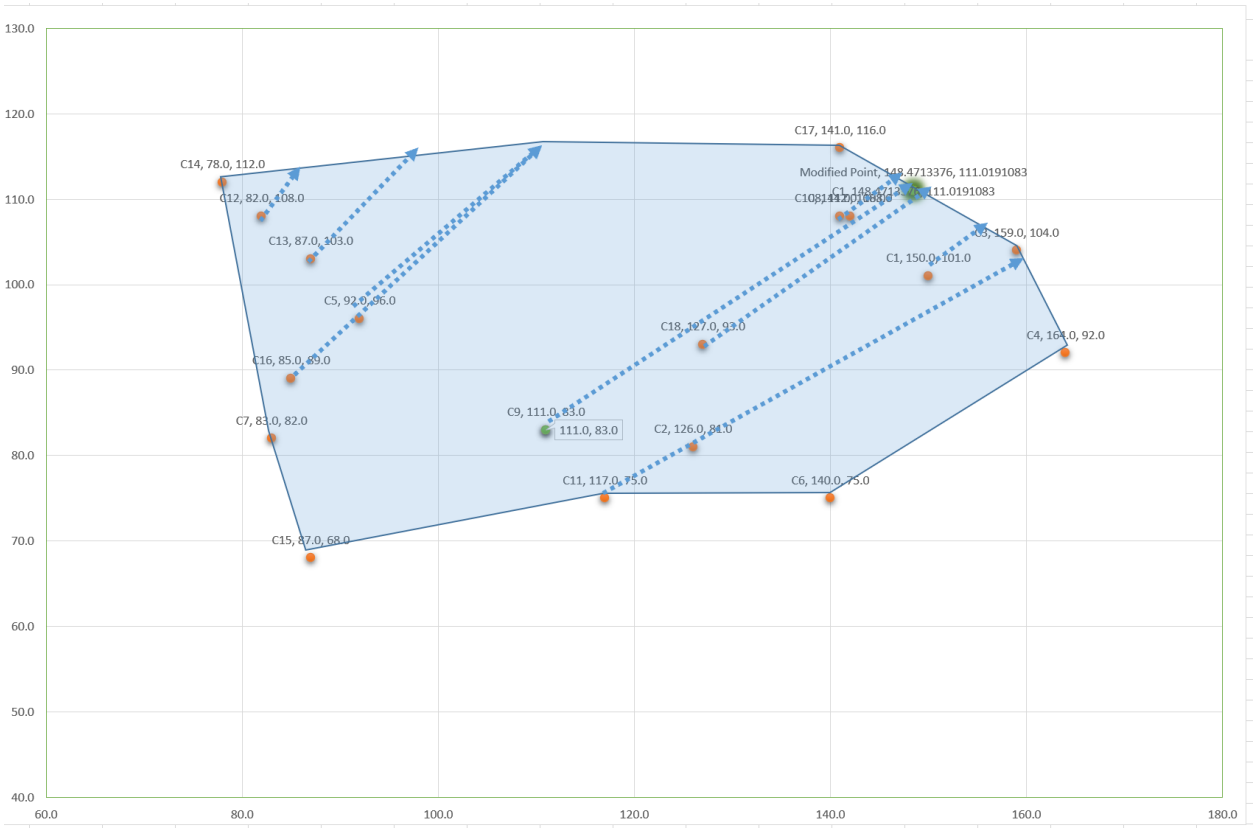


Figure 51: Case 1 Data Envelope analysis

Similarly, the same technique is applied on Contract C13 as shown in table 30. This contract Scores 87 for Project Scope, which is relatively not favorable to the contractor, however it scored 103 for Financial Model which is one of the highest values. the calculations revealed that C13 has an E value of 1.126, i.e., for C13 can be improved by 12.6% for its conditions to be favorable to the contractor in terms of these 2 categories.

Figure 52 shows the modified location of C13. It is evident that the new location is outside the drawn polygon. This is because the convex hull depicted in red, continues in a straight line after the highest point. Thus, C14 which is at the convex hull and still has room for improvement. Therefore, for C13 to be on the convex hull, it will go outside the drawn shape to reach the optimum value that can achieved for this contract to be favorable to the Contractor.

The same was computed for all the contracts to identify their respective locations on the convex hull using the same technique and the possibility of improvement in each contract. Arrows are drawn to show how each contract can be improved and its location on the Convex hull. Contracts at the bottom of the graph will have the highest E value and are least favorable to the contractor as their terms will have to modified significantly, to reach the optimum values.

	Category 1: Project Scope	Category 2: Financial Model	Weights
C1	150.0	101.0	0
C2	126.0	81.0	0
C3	159.0	104.0	0
C4	**164.0**	92.0	0
C5	92.0	96.0	0
C6	140.0	75.0	0
C7	83.0	82.0	0
C8	142.0	108.0	0
C9	111.0	83.0	0
C10	141.0	108.0	0
C11	117.0	75.0	0
C12	82.0	108.0	0
C13	87.0	103.0	0
C14	**78.0**	112.0	0
C15	87.0	**68.0**	0
C16	85.0	89.0	0
C17	141.0	**116.0**	1
C18	127.0	93.0	0
		E	**1.126213592**

Conditions			
Constraints	**Constraint 1**	**Constraint 2**	**Constraint 3**
	141	116	1
Modified Point	**97.98058252**	**116**	1
Contract Analyzed	**87.0**	**103.0**	

Table 30: Case 1 -Data Envelope analysis C15

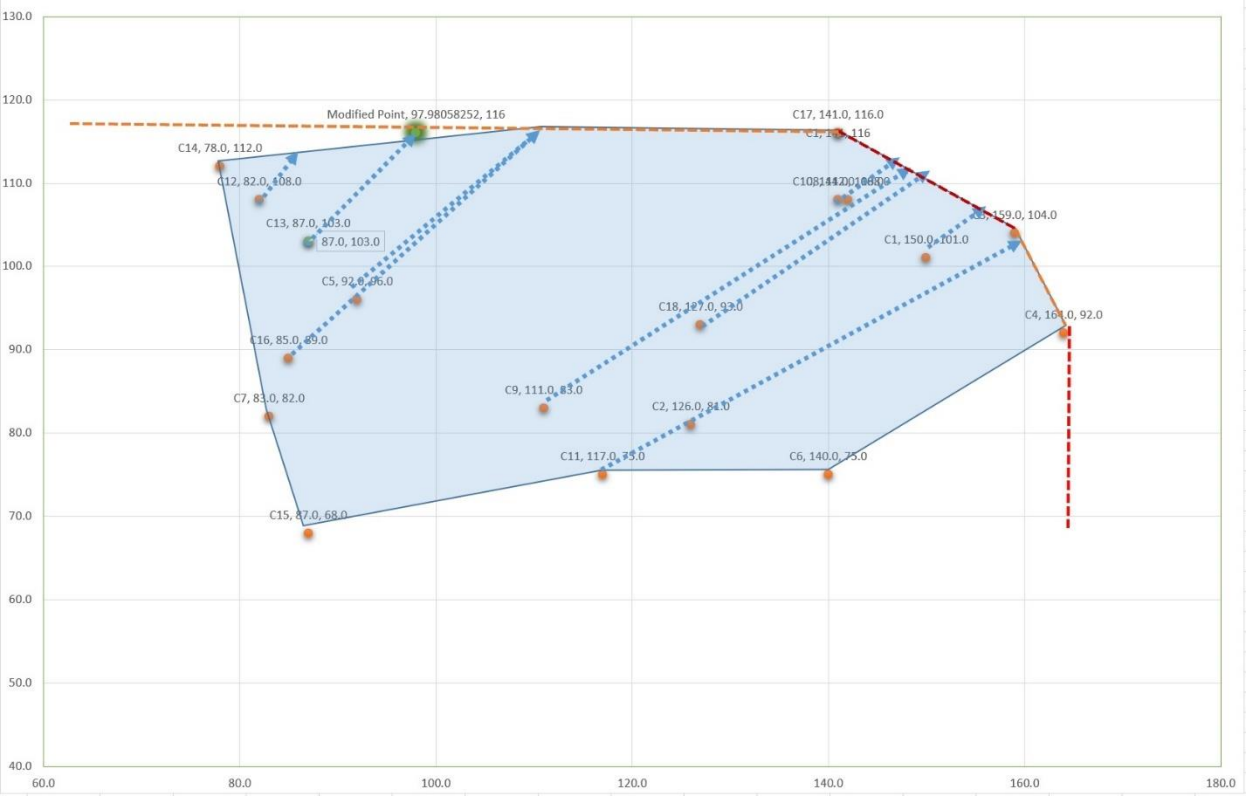


Figure 52: Case 1 Convex hull depicted.

5.2.2 Case 2: Category 3 Operations (OP) Vs Category 4 Claims and Variation (CV):

Similarly, the contractor may choose any categories and compare their performance together. In this case, Category 3 and Category 4 are compared together to identify the most favorable combination of contract provisions within these two categories, and in which contracts where they identified. Contracts C4, C1 & C12 contained the optimum combination of provisions and where therefore located on the Convex hull.

The equation used in this model are:

Eq (5) = ∑ [(OP of C1 ×Weight) + (OP of C2 ×Weight) + (OP of C3 ×Weight) +…. (OP of C18 ×Weight)]

Eq (6) = ∑ [(CV of C1 ×Weight) + (CV of C2 ×Weight) + (CV of C3 ×Weight) +…. (CV of C18 ×Weight)]

And the Constrains are as follows:

- Constrain 1: For Category3: (CBI of OP × E value) ≤ Eq (3)
- Constrain 2: For Category4: (CBI of CV × E value) ≤ Eq (4)
- Constrain 3: WC1 + WC2 + WC3+……..+ WC18 = 1

Contract C7 is used as a hypothetical project in this model and the values obtained in Category 3 operations and category 4 claims and variations are inserted in this model. C7 scored 175 in the operations category, which is relatively a high value and therefore favorable to the contractor, however it scored 51 for the claims and variations provisions which is one of the lowest values. The calculations revealed that C7 has an E value of 1.106, i.e., C7 can be improved by 10.6% for its conditions to be favorable to the contractor relative to the analyzed contracts in Egypt. From this the contractor may opt to renegotiate the contract conditions either related to the claims and variations category or to modify the critical provisions that will restore the balance from the contractor's perspective.

Figure 53 plots the location of all he analyzed contracts in terms of these two categories. It is clear that C7 is located within the boundary away from the convex hull. The green dot plotted on the periphery locates the improved position of the contract. On the same graph it appears that some of the plotted contracts are pointing outside the highlighted boundaries. For instance, C18 this is because the convex hull after the last point (C12) tends to go downward vertically, thus C18 is

Table 31: Case 2 -Data Envelope analysis C7

	Category 3: Operations	Category 4: Claims & Variations	Weights
C1	182	61	0.493085881
C2	142	30	0
C3	**118**	41	0
C4	153	**67**	0
C5	*147*	51	0
C6	123	50	0
C7	175	51	0
C8	139	62	0
C9	194	44	0
C10	190	39	0
C11	177	52	0
C12	**205**	52	0.506914119
C13	148	51	0
C14	192	55	0
C15	136	**33**	0
C16	176	54	0
C17	166	62	0
C18	184	39	0
		E	**1.106622999**

Conditions

Constraints	**Constraint 1**	**Constraint 2**	**Constraint 3**
	193.6590247	56.43777293	1
Modified Point	**193.6590247**	**56.43777293**	1
Contract Analyzed	**175**	**51**	

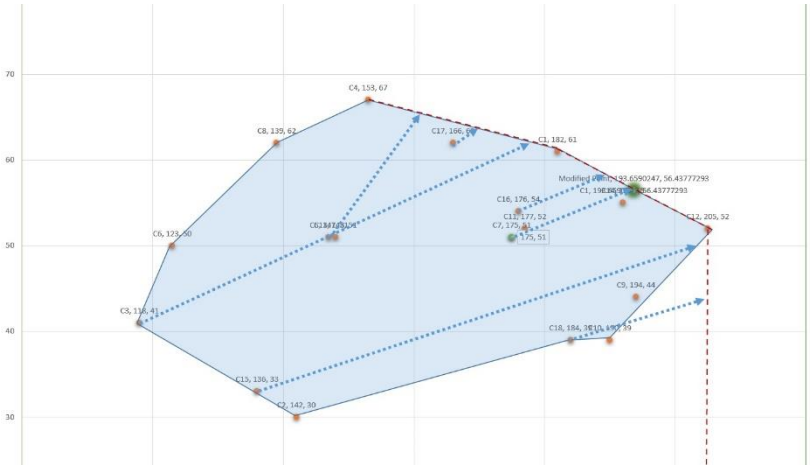


Figure 53: Case 2 Data Envelope analysis and covex hull

pointing to its modified location on the convex hull.

5.2.3 Case 3: Analyzing Entire Contract

The last case demonstrates how the entire contract can be evaluated using the same methodology but with 7 categories of the contract incorporating all the gathered contract provisions. The equations used in this model are the Eq (3 to 9) stated in chapter 3, with the below constrains applied:

- Constrain 1: For Category 1: (CBI of PS × E value) ≤ Eq (3)
- Constrain 2: For Category 2: (CBI of FM × E value) ≤ Eq (4)
- Constrain 3: For Category3: (CBI of OP × E value) ≤ Eq (5)
- Constrain 4: For Category4: (CBI of CV × E value) ≤ Eq (6)
- Constrain 5: For Category4: (CBI of EOT × E value) ≤ Eq (7)
- Constrain 6: For Category4: (CBI of LDR × E value) ≤ Eq (8)
- Constrain 7: For Category4: (CBI of TR × E value) ≤ Eq (9)
- Constrain 8: WC1 + WC2 + WC3+……..+ WC18 = 1

In this scenario, for each contract there are 7 inputs, thus each contract is depicted on 7 axes creating a polygonal 7 dimensioned shape. While the frontier will be based on the intersection of these frontiers together and computing the farther of these. Using Microsoft Excel Solver, this Simulation model is solved to evaluate how far is a new contract away from the frontier created. Thus, this contract evaluation method is based computing the risk balance index for a new contract and inserting the results in this simulation model, that computes the performance of the contract compared to the previously results, hence eliminating any subjective results. Table 32 below shows the inputs of the 7 categories for each contract.

Table 32: Case 3 Data Envelope Analysis for entire contract

	Category 1: Project Scope	Category 2: Financial Model	Category 3: Operations	Category 4: Claims & Variations	Category 5: Liquidated Damages & Extension of Time	Category 6: Limitation of Liability	Category 7: Terminations	Weights
C1	150	101	182	61	**45**	15	84	0.0000
C2	126	81	142	30	21	24	90	0.0000
C3	159	104	**118**	41	38	16	93	0.0000
C4	**164**	92	153	**67**	22	17	79	0.0000
C5	92	96	*147*	51	38	15	79	0.0000

C6	140	75	123	50	36	20	86	0.0000
C7	83	82	175	51	34	18	76	0.0000
C8	142	108	139	62	26	14	84	0.0000
C9	111	83	194	44	26	**13**	84	0.0000
C10	141	108	190	39	20	14	79	0.0000
C11	117	75	177	52	31	15	79	0.0000
C12	82	108	**205**	52	22	15	**72**	1.0000
C13	87	103	148	51	34	23	83	0.0000
C14	**78**	112	192	55	24	15	**72**	0.0000
C15	87	**68**	136	**33**	23	**26**	**103**	0.0000
C16	85	89	176	54	**13**	15	**72**	0.0000
C17	141	**116**	166	62	32	14	84	0.0000
C18	127	93	184	39	23	15	**72**	0.0000
							E	1.0000

Constraints	**Constraint 1**	**Constraint 2**	**Constraint 3**	**Constraint 4**	**Constraint 5**	**Constraint 6**	**Constraint 7**	**Constraint 8**
	82	108	205	52	22	15	72	1
Modified Point	82	108	205	52	22	15	72	
Original point in Question	82	108	**205**	52	22	15	**72**	

For each of the gathered contracts the results are inserted in the model to identify the performance of the contract and compute the E value. The results for the 18 contracts are demonstrated in the table below. The results of this case showed that 12 out of 18 contracts had an E value equal to 1, i.e., these contracts are on the frontier. While only 6 contracts had an E value greater than one, revealing potential for improvement.

Moreover, in cases 1 & 2 discussed above, the sensitivity of the E value was much higher, showing larger E values that were demonstrated on the graphs. Meanwhile, the E values in this case revealed in these 6 contracts that they are marginally higher than 1. This could be because having 7 axes made the model very complex, hence making the sensitivity very low. Despite this, these 6 contracts are the ones that showed an E value higher than 1. Thus, it could be concluded that despite the E value is not significantly higher than 1, and the improvement degree of these contracts does not exceed 7.7%, and having a low sensitivity of the model, these contracts are away from the frontier.

The results of the model are presented in table 33, which suggests that this approach is suitable to evaluate several different contract categories together and compare these with other contracts. While the model sensitivity is more applicable for a couple of categories and will reveal the improvement that could be done to these categories accurately. However, in evaluating the 7 contract categories the E Value may not reflect the actual improvement or the difference between the contracts. It is suggested that this may be because the variations in the Risk balance index values obtained from previous sections may not be comparable for some categories, for instance in the Claims and variations category the values ranged from 32 to 66 over the 13 provisions being analyzed as opposed to category 3 (operations) which ranged from 118 to 205, this may limit the capabilities of the model. Modifications to improve the sensitivity of the model and make the inputs of the model more relative to each other might help to overcome this issue.

Table 33: Case 3 Data Envelope analysis Results

Modified contract locations	Category 1: Project Scope	Category 2: Financial Model	Category 3: Operations	Category 4: Claims & Variations	Category 5: Liquidated Damages & Extension of Time	Category 6: Limitation of Liability	Category 7: Terminations	E Value
C1	150	101	182	61	**45**	15	84	1
C2	126	81	142	30	21	24	90	1
C3	159	104	**118**	41	38	16	93	1
C4	**164**	92	153	**67**	22	17	79	1
C5	99	103	*158*	55	41	16	85	1.077525133
C6	140	75	123	50	36	20	86	1
C7	83	82	176	51	34	18	76	1.003626108
C8	142	108	139	62	26	14	84	1
C9	111	83	194	44	26	**13**	84	1
C10	141	108	190	39	20	14	79	1
C11	122	78	185	54	32	16	83	1.046260627
C12	82	108	**205**	52	22	15	**72**	1
C13	122	78	185	54	32	16	83	1.04626035
C14	**78**	112	192	55	24	15	**72**	1
C15	87	**68**	136	**33**	23	**26**	**103**	**1**
C16	90	94	186	57	**14**	16	**76**	1.056831817
C17	141	**116**	166	62	32	14	84	1
C18	129	95	187	40	23	15	**73**	1.018816132

To conclude, this technique improves the Contract evaluation in the following ways:

1) As stated in the beginning of the research, contract documents should be read and evaluated as a whole, which is the main outcome of this technique, moreover it presents an objective evaluation of the entire contract.
2) The contractor is able to measure the performance of the contract relative to real projects in Egypt in the past years and determine if the contract terms of a new project is favorable to the Contractor or not.
3) This method reveals the degree of improvement that can be achieved in the contract; hence the contractor can revert back to the Risk balance index of each category and by modifying some contract terms can improve the performance of the entire contract to restore the balance.
4) Avoids using any subjective methods that relies on surveys, questionaries or interview that rely on the experience of the respondents to evaluate the contract.
5) Avoids the use of weights obtained from surveys to determine the importance of contract term, as these weights are relative to each contractor.
6) The contractor can choose the important contract categories either all 7 or only a couple of them based on their experience and evaluate the performance of these categories only.

In the previous chapter the common contract provisions were analyzed separately, while this chapter have attempted to evaluate the contract provisions using two techniques. The first is by creating an index for a group of contract terms that are categorized together and using radar charts to evaluate the performance of this group of terms. The contract balance index (CBI) is computed from the area of the radar charts and calculated for all the gathered contracts to act as a datum line. It can also be calculated for each category of a new contract to assist in comparing the results and identify the risky provisions that needs to renegotiate to restore the balance in the contract. The second technique presented is using Data envelope analysis to evaluate the performance of the entire contract or two or more contract categories together and determine the degree of improvement that can be done in order for the contact to be on the frontier of the convex hull. This method avoids the use of weights from surveys etc. and relies on objective data solely. The final chapter will dictate the conclusion of this research and the limitations of this research with any the recommendation for future research.

Chapter 6: CONCLUSION AND FUTURE RECOMMENDATIONS

This research has three main objectives which were to identify the contractual risks and main causes of delay, to define the most common contract terms and conditions implemented in lump sum contacts in Egypt and finally to present a methodological framework for the evaluation of the contract terms and conditions. The reviewed literature disclosed that contract evaluation is vital for contractors as the contract is usually drafted by the employer, while a sound contract should clearly address the contractual risks in a contract and to be communicated to both parties so that each party can understand its obligations and rights. While there is a need for proper contract evaluation, this research attempted to study the contract evaluation techniques and presented a new method for the evaluation of the contract terms. In addition, to experimenting the use of visual techniques researched by several authors in contract evaluation. This chapter discuss the conclusion of this research, its limitations to be considered by the readers and the recommendations for future works.

6.1 Conclusion

- The Lump-sum provisions implemented in Egypt were gathered from 18 lump sum contract and for each of the critical contract provision, and the results are compared against the Egyptian civil code and the FIDIC standard contract provisions. It appeared that some of the contracts lacked some provisions that are already stated in law, while some contracts had some provisions that are contradicting with Egyptian civil code, hence the contractor should be aware of these laws. With this step this research was able to satisfy the second sub-objective of analyzing the terms and conditions of lumpsum contracts in Egypt.
- The Contract Balance Index (CBI) was created to evaluate a group of contract terms and provisions together and compare the results with other contracts. In this way, contractors are able to focus of specific contract terms that incorporates the highest risk from their perspective and identify if these conditions are favorable or not compared to previous project.
- As for any index, the evaluation method should be standardized. Thus, a web tool was created to unify the insertion of contract terms and provisions and standardize the evaluation method, thus obtaining a Contract Balance Index for each of the Contract categories that is

measurable and comparable to another contract. The web tool also incorporated the statistical results for each contract term solely to help the contractor in analyzing each contract provision alone. With this analyses the research was able to satisfy the third subobjective of the evaluation of the contract terms and conditions,

- The Contract Balance Index for each category of the 18 Lump Sum contracts has been calculated to act as a datum line in this technique. The results and then compared with each other to determine the most optimistic contracts and the least favorable contracts for each category. And discussion of these results was presented to assist in comparing new contracts and identify the risky provisions that needs to renegotiate for each category to restore the balance in the contract.
- Upon determining the critical contract provisions and the risk balance index of every category, most of the literature tend to rely on surveys, questionnaire, or interviews to identify the impact of every contractual risk or the weights relative to the contractor. The results of these surveys are subjective and depends on a lot of variable. While this research opted to determine the performance of the contract and the degree of improvement using Data envelope analysis.
- Data envelope analysis is a linear programming technique that was used to evaluate the performance of the contract using a set of entities called Decision making units (DMUs). The DMUs in this case is the Contract balance Index obtained for every category and applying several constrains, to determine the frontier values of the gathered contracts. The results of this techniques show how the contract can be improved and in which categories. It can also be used to compare several categories from different contracts together of the entire contract.

Finally, this research satisfied the main objective with an innovative methodology for contract evaluation, that relies on visualization technique, and statistical analysis to evaluate the contract terms and by presenting a Linear programing method that is used to evaluate the entire contract, which does not rely on weights or any of the subjective methods implemented in previous research.

6.2 Research Contributions

This research contributes by adding to the literature of contract evaluation and the visualization of contact terms. It discusses the contract evaluation techniques and the implementation of visualization in contract evaluation. The results of the research add to the literature by presenting a comparison between the common lump sum contract conditions in Egypt with the Egyptian Civil Code and the FIDIC standard Contract. Furthermore, the methodology implemented in this research utilizing a Data envelope analysis in contract evaluation is considered a genuine contribution as it was not utilized in this area before.

Moreover, this research contributes to practice, by providing a contract evaluation checklist that is included in Appendix A, to be used by contractors during the tendering stage to evaluate a new project. The results of this research also allow the contractors to identify the most common lump-sum contract terms implemented in Egypt. Finally, it presents a tool to calculate the Risk Balance Index and to evaluate the entire contract provisions, such tool incorporates statistical analysis for the results of the research to enable the contractor to negotiate better contract terms and conditions.

6.3 Limitations of the Research

The following points are considered as limitations to the research:

- This research is focused on Lump-Sum contracts in Egypt and did not consider any other types of contracts or other project types. It is understood that other contract types may entail different contract provisions and hence a different risk balance. However, this research attempted to narrow down the scope to demonstrate how the contract terms can be evaluated numerically, without relying on Subjective approaches.
- For the Risk balance Index calculations using the radar chart be accurate and the results can be repeated, each of the contract terms must be placed on its respective axis to standardize the calculation and comparison. Additionally, Radar charts assumes that each axis has the same weight, while this may not be the case for all contractors.
- The list of contract provisions used to analyze the contracts were extracted from literature and from another research conducted in Egypt. While it was not verified by experts' survey or interviews who may have had other suggestions for additional contract provisions that

may be included in the evaluation. However, every Contractor may have his own evaluation means, or may be focused on a different set of contract provisions that entails the highest risk on his work.

6.4 Recommendations for Future Research

Few research has been conducted to evaluate the contract terms and provisions or to reveal the most common contract provisions utilized in a certain country or a specific contract type. While the majority of the research is focused on identifying the contractual risks and their frequency of occurrence and significance on the project or the Contractor. Meanwhile, they're not enough research that present a framework on how contract terms can be analyzed numerically, nor there is enough information about the actually contract provisions and their wording enforced in a certain country. Accordingly, the following topics are recommended to for future research:

- Evaluation of contract terms for other contract types such as cost plus or remeasured contracts and comparing the most common contract provisions implemented in them with the results of this research.
- A comparison between the contract evaluation methods using checklists or surveys will be useful for contractor o determine the optimum evaluation technique for them.
- It is recommended to study objective evaluation technique and implement other visualization techniques to avoid the subjective approaches utilized to identify the contractual risks.
- Examine the use of Data envelope analysis technique to present how linear programming can evaluate the entire contract without the need to rely on the risk balance index obtained from the radar charts.

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APPENDIX A: Preliminary list of terms and conditions

Ref No:	Criteria	Answer type:
PS	Performance security	Y/N
PS1	Is Performance Bond Required	Y/N
PS2	What is the Submission date of Performance Bond After Commencement	N
PS3	Which Party is responsible for obtaining and Keeping the Bond	C/E
PS4	What is Performance Bond Percentage	N
PS5	What is Advance Payment percentage	N
PS6	What is Retention Percentages:	N
PS7	Does the Advance Payment Bond Decreases with Time	Y/N
CD	Commencement Date:	
CD1	Is there s Specified Commencement date	Y/N
CD2	Is receiving Advance Payment Condition Precedent for Commencement date	Y/N
CD3	Is receiving Site Possession Condition Precedent for Commencement date	Y/N
PWs	Program of works/revised program	
PWs1	Is the Commencement of works defined	N
PWs2	When is the Programme Submission by Contractor	N
PWs3	What is the Review Period by PM	N
days	When is Submission period of rejected Programme	N
PWs5	What is the Progress report Submission Period	N
PWs6	Are there consequences of failing to submit or obtain approval to program.	Y/N
CP	Contract price, and its relation to customs, taxes, etc.	
CP1	Is the Contract price Fixed	Y/N
CP2	Contract Price Inclusive of All tax's ad Duties	Y/N
CP3	Are the BOQ quantities are Fixed & contractor do not have to abide by it	Y/N
CP4	Which Party is Responsible for Taxes, Levies Duties, VAT, VAT for contracting service, Social Insurance	C/E
CP5	Are there Fixed Rates and Prices	Y/N
CP6	Is the Contractor required to Submit Breakdown for BOQ items After Commencement	Y/N
CP7	Is there an Obligation to submit Breakdown for every Item? Upon request by Employer	Y/N
CP8	Is the Employer obliged to Abide by contractor's breakdown	Y/N
CP9	Contract Price Escalations:	Y/N
CP10	Does the Contract allow for Price Escalation	Y/N
CP11	Are these items subject to Escalation (Steel, cement, Diesel, Dollar)	Y/N
CP12	Steel	N
CP13	Cement	N
CP14	Diesel	N
CP15	Dollar	N
CP16	Earthworks	Y/N
CP17	Adjustment For Changes in Legislations:	Y/N
CP18	Does the contractor provisions allow adjustments for Changes in law	Y/N
CP19	Is the Contractor obliged to Notify the PM with changes in Legislations	N
CP20	Is the Contractor entitled To Profit or Overhead in case of Change in Legislations	Y/N
L	Language and law	
L1	Is the Language of the contract and the country same as the contractor	Y/N
L2	Which party bears the costs associated with complying by the language requirements in dealing with authorities and others.	C/E
PDs	Priority of documents	
PDs1	Does the contract state a Hierarchy of documents	Y/N
PDs2	In case of Documents with same Priority, Is the Higher standard defined	Y/N
PDs3	Are Ambiguities in documents considered Variations	Y/N
VR	Variations	
VR1	Which Party is entitled to issue Variations	E/PM/SC
VR2	What is the percentage of Allowed Variations	N
VR3	What is the percentage of benefit to the contractor as a result of Value Engineering	N

VR4	Which party nears Cost of Value Engineering study and Proposal	C/E
VR5	Is the contractor obliged to proceed with instructed variations whether an agreement on price has been reached or not.	Y/N
VR6	What is the Duration to Submit Notice of Cost and time Impact	N
VR7	What is the Duration To submit Variation Particulars	N
VR8	What is the percentage of overhead and profit to be used for evaluation purposes	N
VR9	What is the Variations Valuation procedure	options
CLm	**Claims:**	
CLm1	State the Period to submit notice of claim	N
CLm2	State the Period to submit claim Particulars	N
CLm3	What is Lowest Claim Value to be considered	N
CLm4	Is there a Period after which contractor can claim Prolongation Cost	N
IPC	**Payment**	
IPC1	**Currency of Payment:**	
IPC2	Is the Currency of Payments Egyptian Pound	Y/N
IPC3	Is there a specific date of Receiving Advance Payment	Y/N
IPC4	Does the contract allow the Contractor to Object on Issued Payment	Y/N
IPC5	**Interim Payments:**	
IPC6	When is Submission of Interim Payment	N
IPC7	Are there Condition of Submission of Interim Payment	Y/N
IPC8	Interim payment certificate shall include	Options
IPC9	What is the Review Period of IPC by Supervision Consultant	N
IPC10	What is the Review Period of IPC by PM	N
IPC11	What is allowed duration for the Employer to Issue Payment	N
IPC12	What are the consequences if the contractor failed to provide all supporting documents	N
IPC13	For works not available in the drawings, but present in the BOQ Does the Contractor get Paid at the end of the Item works	Y/N
IPC14	**Delayed IPC Payments**	**Y/N**
IPC15	Is the Contractor is entitled to reduce rate of progress if IPC is delayed	N
IPC16	Is the Contractor entitled to EOT if IPC is delayed	Y/N
IPC17	Is the Contractor is Entitled to Interest For delayed Payments	Y/N
FC	**Final Certificate:**	
FC1	Duration for Submission of Final Certificate:	N
FC2	State the Review Period of IPC by PM	N
TOC	**Take Over Certificate:**	
TOC1	Are the Completion of tests Condition Precedent	Y/N
TOC2	Is the Submission of As Built drawings, Manuals & operations etc. Condition Precedent	Y/N
TOC3	Is the contractor responsible for the care of the parts of the works that may be used by the employer	Y/N
TOC4	In Case of Taking over of Portion of works what is the percentage of Retention returned	N
EOT	**Extension of Time:**	**Y/N**
EOT1	Does the contract state “Time is Of Essence”	Y/N
EOT2	what is the Duration to Submit EOT notice	N
EOT3	Can the Engineer consider any omitted works in EOT evaluation	Y/N
LDs	**Liquidated damages:**	**Y/N**
LDs1	Does the contract state a Grace Period	Y/N
LDs2	What are the Max LDs applied	N
LDs3	Describe the Application of LDs	Options
LDs4	Can the Employer to deduct monies from the contractor without prior notice	Y/N
MLs	**Intermediate milestone available**	**Y/N**
MLs1	Does the contract state Penalty for not meeting the intermediate milestones	N
MLs2	Is the penalty Recoverable	Y/N
LL	**Limitation of Liability**	**Y/N**
LL1	What is the Contractor Liability limit	N
CL	**Consequential Losses:**	
CL1	Is the contractor entitled to claim for loss of profit (Lost opportunity) for exceeding project duration/ early termination	Y/N

DR1	Dispute Resolution	
DR	Does the contract state the Presence of Dispute resolution method (DAB/ Mediation/ litigation)	Y/N
DR2	Does the contract allow Arbitration	Y/N
DR	Is the seat of arbitration in the Local Country	Y/N
DR3	Is the Language of Arbitration same as contract Language	Y/N
DR	Is the Award by Arbitrators deemed Final and Binding by court	Y/N
DR4	How many Committee Members	N
DR	When id the Duration To commence with arbitration from dispute date	N
TR	Termination:	
TR1	Does the contract allow Termination by Employer for inconvenience	Y/N
TR2	Does the contract allow Termination in case Contractor did not submit Insurances	Y/N
TR3	Does the contract allow Termination due to "Time is of Essence"	Y/N
TR4	Does the contract allow Termination due to liquidation	Y/N
TR5	Is the Employer entitled to Terminate the contract in case of reaching LDs limit	Y/N
TR6	Is the contractor is obligated to pay to other Subcontractor any amounts payable in case of termination	Y/N
TR7	Does the contract allow the contractor to claim for loss of profit for termination	Y/N
TR8	Is the Contractor allowed to terminate if the employer did not issue interim payment within the agreed duration and without contractual basis	Y/N
FM	Frustration And force Majeure	
FM1	Does the contract allow Termination due to Frustration	Y/N
FM2	What are the Conditions for Termination due to frustration	Options
FM3	What are the Inclusions of Force Majeure Events	options
FM4	Is the Contractor obliged to Submit Notice of Force Majeure	N
FM5	Is the Contractor entitled to Monies for incomplete or work not inspected by Supervision consultant	Y/N
FM6	Does the contract state Contractor Obligation to Confidentiality after Termination	Y/N
FM7	Does the contract state Contractor Obligation to Inherent Defects after Termination	Y/N
FM8	What is the Period of inherent defects which contractor is obligated to maintain	N
FM9	What is the contractor's liability	Structure/ All works
Rs	Expected Risk:	
Rs1	Is the Contractor entitled to Claim EOT and/or Time for events outside of his control	Y/N
Rs2	Is the Contractor entitled to Claim Country related events (war- riot-terrorism- rebel- Invasion-revolution)	Y/N
Rs3	Is the Contractor entitled to Claim Weather Conditions (Rain- Sandstorm- tsunami - Floods- earthquake-fire etc.)	Y/N
Rs4	Is the Contractor entitled to Claim Insufficiency of design Drawings	Y/N
Rs5	Is the Contractor entitled to Claim Ionizing Radiations or Contamination by Radioactivity	Y/N
Rs6	Is the Contractor entitled to Claim Pressure waves by Arial devices	Y/N
Ins	Insurance:	
Ins1	Which party bears the Cost Of obtaining and maintain all insurance certificates	C/E
Ins2	Is the employer entitled for notice from the insurers prior to changes of coverage or failure to renew policies	N
Ins3	Is the contractor to obtain a waiver by insurance companies of any and all rights of subrogation they might be able to exercise against the Employer or its representatives.	Y/N
Ins4	Does the contract Require the contractor to insure third-party automobiles	Y/N
Ins5	Does the contract Require the contractor to insure against loss or damage to the plant prior to its delivery and during its unloading to site	Y/N
Ins6	Indemnify the employer against all losses and claims arising from the contractor's failure to comply by the conditions related to insurance policies.	Y/N