

CHANGING ORDER DURING THE IMPLEMENTATION PHASE OF PROJECTS UNDER NATIONAL AND INTERNATIONAL CONSTRUCTION CONTRACTS

Nourhan Hazem Mohamady^{1,*}, Akram Farouk¹, Moataz Abd El Ftah¹

¹ Department of Architecture - Faculty of Engineering - Ain Shams University.

* Correspondence: Nouri.hazem93@gmail.com

Received: 28 August 2022 Accepted: 5 Nov.2022

ABSTRACT

Change orders is one of the main problems facing construction projects during the implementation phase, they have bad effects on cost and time. The problem is there is no understanding of the contract clause that refers to variations and how all parties manage their rights to deal with it during the construction phase. Accordingly, this research aims to develop the current change orders management in Egypt during the implementation phase of government projects under national contracts. To achieve this aim, a research methodology is designed. Firstly, a literature review is used to make background about change order's legal aspects under national and international contracts. Secondly, a questionnaire is designed to determine the methods used to manage change orders. Data analysis revealed that disputes up to 60% of the cases, and burden the contractor up to 88% of the risk. The research concludes that the management of change orders in Egypt needs a strategy to minimize disputes, between parties of the contract.

Keywords :Change order, FIDIC, Law NO.182 of the year 2018, projects management.

أوامر التغيير خلال مرحلة تنفيذ المشروعات فى ظل عقود التشييد المحلية و الدولية

نورهان حازم محمدى^{1,*}، أكرم فاروق¹، معتز عبد الفتاح¹

¹ قسم الهندسة المعمارية، كلية الهندسة، جامعة عين شمس، القاهرة، مصر

* البريد الإلكتروني: Nouri.hazem93@gmail.com

الملخص

أوامر التغيير هي إحدى المشاكل الرئيسية التي تواجه مشاريع البناء أثناء مرحلة التنفيذ ، ولها تأثير سلبي على زيادة تكلفة المشروع والتأخير في مدته. تكمن المشكلة في عدم وجود فهم لشرط العقد الذي يشير إلى الاختلافات وكيف يدير جميع الأطراف حقوقهم في التعامل معها خلال مرحلة التنفيذ. وبناءً عليه يهدف هذا البحث إلى تطوير إدارة أوامر التغيير الحالية في مصر خلال مرحلة تنفيذ المشروعات الحكومية في ظل القانون المصري الذي يحكم هذه العملية. لتحقيق هذا الهدف ، تم تصميم منهجية بحث. أولاً ، يتم استخدام مراجعة الأدبيات لتكوين خلفية عن أوامر التغيير بالإضافة إلى دراسة الجانب القانوني في مصر الذي يحكم أوامر التغيير والتعرف على إدارة أوامر التغيير في عقد الفيديك الأحمر للاستفادة منه . ثانيًا ، تم تصميم إستبيان لمعرفة الطرق المستخدمة لإدارة أوامر التغيير و توضيح القصور الموجود حالياً. كشف تحليل البيانات أن النزاعات تصل إلى 60% من الحالات ، ويتحمل المقاول بنسبة تصل إلى 88% من المخاطر ، ولخص البحث إلى أن إدارة أوامر التغيير خلال مرحلة تنفيذ المشروعات في مصر تحتاج إلى استراتيجية لتقليل الخلافات بين أطراف العقد.

الكلمات الدالة : أوامر التغيير ، عقد الفيديك ، قانون رقم 182 لسنة 2018 ، إدارة المشاريع.

1. INTRODUCTION

Construction projects often have conditions and variations that are not precisely known during the design phase but can be well understood later. One of their biggest problems can be the issuance of change orders throughout the construction phase. It is difficult to ensure that a construction project is built unchanged. This is usually due to several causes attributed to the various parties involved in executing the project [1]. Therefore, construction contracts often include change order clauses that describe how change orders will be managed through the project. The contract's provisions for adjustments and variations permit the client to request changes to the scope of the work without altering the initial agreement [2]. “change orders” becomes a critical clause in the Contract Conditions since disagreements between the project parties typically depend on who is responsible for paying for what expenses. With the aforementioned knowledge, an appropriate change orders clause may be the most practical technique for handling any changes in work. Almost all recognized international standards for construction contracts include terms that allow the client to add and/or remove work or its quality [3]. Variation orders are legally the approved changes in a specification of a project. The occurrence of change orders on construction projects appears unavoidable in a developing nation like Egypt where there is a modern building boom going on. Since it can be difficult to imagine the end product the client wants., the degree of modification should always be expected. Even if it is difficult to avoid changing order, if their origin and causes are clearly understood, they can be limited or even prevented. This research is the first of its kind in Egypt, as it attempts to help gain a deeper insight into the status of variation order management from the contractor's perspective in the Egyptian construction sector.

1.1 RESEARCH PROBLEM

A lot of research has been done to understand the causes of change orders and their impact, However, there is a knowledge vacuum on the contract clause that refers to change orders and how all contracting parties manage their respective rights to deal with it during the construction phase. In terms of construction, Egypt is presently undergoing significant development. Understanding the contract provision that refers to changes in construction is crucial. To produce a final product that is profitable for the developer, advantageous to society, and does not violate the rights of the contractor.

1.2 AIM AND OBJECTIVES:

Develop the current change orders management in Egypt during the implementation phase of government projects under national contracts.

Through:

- a) Literature review study about causes and impact of the change order and the legal aspect that governs change orders in the Egyptian contract and getting acquainted with the management of change orders in the FIDIC red book contract to benefit from it.
- b) Analyze the current status of change orders management during the project implementation phase.
- c) Knowing the disadvantages of the current administration and providing a strategy to avoid the current deficiencies in the change orders management during the implementation of projects and apply to the current situation to reduce damages and disputes.

1.3 SCOPE OF WORK

The scope includes an analysis of changing order condition of construction contracts of recent projects related to public sectors in Egypt, these projects are large-size projects with a value starting from 50 million L.E. The type of projects includes residential, commercial, roads, and infrastructure. The participating contractors are the first and second category contractors. Contracts are mostly addressed from a Contractor's Perspective as the contractor is the performing party that may be subjected to any risk or loss.

1.4 RESEARCH METHODOLOGY

In this study, three research methods were used to accomplish the research goals. These methods include.

- a) Literature review that discussed the theoretical background of this research and studied the factors causing variation orders and how to manage its impact.
- b) Analyzing the general conditions (GC) clauses of national and international contracts that cover change orders, their management, and the administrative procedures used to handle them in construction projects.
- c) While the third method was a questionnaire designed to determine the methods used to manage change orders during the implementation phase in Egyptian projects.

To provide better knowledge and practical advantages in this research area, data analysis was applied in these field studies. While the overall design of this study is a questionnaire. The study concludes to extract the status of change order management for Egyptian government projects and suggest strategies to develop the current change orders management in Egypt during the implementation phase of government projects under national contracts.

2. OVERVIEW OF CHANGE ORDER

The definition of change orders is not standardized. The term "change orders" has different meanings according to different standard forms of contract. It is described as additions or omissions of work, materials, working hours, workspace, etc. in the construction contract dictionary. Any modification to the works that is authorized or directed as a variation is referred to as a "variation" under FIDIC. Because all systems change over time, a change or variation is an "unavoidable alteration in the output or results of a system. There are two main categories of variation that are common. They are (1) inherent in systems, and (2) special, which result from modifications in the external environment or conditions. Change orders include changes to the quality, quantity, and timeline of the work as well as additions, omissions, and substitutions. Any modification to the project's objectives and scope of work, regardless of whether it affects the project's budget or timeline, is regarded as a variation. [4]. Variation orders have an impact on overall project

performance. This is because variations can cause substantial adjustments to the contract duration, total direct and indirect cost, or both.

1.5 NATURE OF CHANGE ORDER

By considering both the causes and consequences of change orders, it is possible to identify their type [5]. distinguished between two different kinds of change orders, namely helpful and detrimental change orders.

1.5.1 Helpful change orders:

A helpful change order is issued to enhance a project's quality standard and lower the cost, schedule, or level of difficulty [5]. It is a change order initiated for the purpose of value analysis in order to achieve a project's cost, performance, and durability goals while also satisfying clients.

1.5.2 Detrimental change orders

Change orders that have a negative effect on the client's value or project performance are considered harmful [5]. Arguably, a detrimental change order may potentially undermine the client's core values.

1.6 CAUSES OF CHANGE ORDER

From Previous studies such as [4], [6], [7], [8], and [9] Four origin sources can be used to summarize the main causes. Which are Owners, consultants, contractors, and others who fall under this category.

1.6.1 Owner

Due to poor owner interaction during the design phase, many unneeded modifications occur. Owners with little or no knowledge in the construction sector won't be able to follow the design with the designer to ensure that all of their requirements are met.

1.6.2 Consultant

A contract between the owner and the consultant will often outline the consultant's duties in a construction project. Design errors increase the chance of project change orders and ultimately lead to customer dissatisfaction. The consultant may not be aware of every new product or material that keeps hitting the market. When such new products or materials are chosen and given to the contractor, this may be a variation.

1.6.3 Contractor

The contractor is required to construct following the design. All costs incurred to complete the project as described in the specifications are the responsibility of the contractor. Additionally, the contractor is in charge of notifying the consultant of any technical issues that can result in a change order. Alternative The contractor could suggest different construction techniques based on his experience to let the consultant know that the initial approach won't produce the desired design. This might be a change order.

1.6.4 Other Sources

Weather conditions, changes in national laws, and unforeseen issues are a few examples of events outside the control of the parties to the contract that can result in change orders.

1.7 IMPACT OF CHANGE ORDER

Many authors such as [10], [11], [12], and [13]. have identified the issues that arise most frequently as a result of the variation.

- 1.7.1 Project schedule: Due to the impact of the change order, the client will typically approve a time extension request from the contractor, which results in a delay in the project's completion schedule. [14].
- 1.7.2 Project cost: The impact on contract price is significant and frequently occurs in change orders. [14].
- 1.7.3 Quality degradation: Tendency to produce variations might impact the quality of work
- 1.7.4 Productivity degradation: Because of interruptions, delays, and work redistribution, change orders also have an impact on labor efficiency.
- 1.7.5 Rework & Demolition: Demolition and rework may be necessary if changes were made during the construction process or after a phase was completed.

VARIATION ORDER NATIONAL AND INTERNATIONAL CONTRACT

1.8 LAW NO.182 OF THE YEAR 2018

Right to vary: according to Clause 96 of Resolution No. 692 of 2019 in the ER of Law 182 of 2018, the Administration may order a variation of up to 25% of the respective items' quantity in construction works contracts and up to 15% of the respective items' quantity in other types of contracts, subject to certain approval requirements and restrictions outlined in the ER. The Law expressly foresees a pro-rata schedule adjustment.

In cases of emergency necessity and with the consent of the contracting party, the previous percentage may be exceeded.

In all cases, the contract must be amended, get approval from authorities, and the financial appropriation must be available. And in contracting that requires the implementation of new terms with the knowledge of the existing contractor without others, the contract is made with him with the approval of the competent authority, by way of direct agreement, provided that the prices are appropriate.

Valuation of variation: according to clause 97 in ER, several valuation rules are being explained. The BOQ rate, fair adjustment, market rate, and day work rate are used to value changes under this contract.

Extension time for completion: The competent authority may give the contractor an extension time to finish the contract without incurring a penalty if the start of the work is delayed for circumstances outside of his control. Without having to provide the contractor any notice or takes other action, a delayed penalty will be imposed from the contract's extended completion date if the contractor fails to comply with the execution schedule for reasons that can be traced back to him. Following is how the delay penalty will be determined:

If the overall duration of the operation does not exceed 10% of the delay, the total delay penalty for construction work shall not exceed 10% of the contract value. If the delay lasts longer than the aforementioned amount of time, the penalty will increase to 15%. However, if it is determined that the delay was caused by circumstances outside of the contractor's control, exemption from this requirement must be given by a decision of the competent authority. In addition, if no harm is done, the competent authority may relieve the contractor, in whole or in part, from the delay penalty. [15].

1.9 FIDIC CONTRACT

Right to vary: Sub-clause 13.1 states that the Engineer is authorized to notify the Contractor of significant changes to quantity and quality at any time by giving instructions or by asking for a proposal from the Contractor. There are restrictions on the Contractor's duty to execute the

Variation even if the Engineer is authorized to do so by the first sentence of Sub-clause 13.1. These are outlined in Sub-clause 13.1's second paragraph:

"The Contractor shall execute and be bound by each Variation unless the Contractor promptly gives notice to the Engineer stating (with supporting particulars) that the Contractor cannot readily obtain the Goods required for the Variation. Upon receiving this notice, the Engineer shall cancel, confirm or vary the instruction."

Valuation of variation: Any variation should be evaluated following Section 12 of the Red Book, in accordance with Section 13.3. This is based on the principle of evaluating work by measuring the amount of each work item, according to sub-clause 12.2. Apply a reasonable rate per unit quantity or a reasonable flat rate in accordance with Subsection 12.3 (Valuation). This section states that the engineer must agree to or determine the value of each work item, and apply measured quantities to rates and prices accordingly.

Extension time for completion: The circumstances or occurrences that may provide the Contractor a right to an extension of the Time for Completion are listed in Sub-clause 8.4 (EOT for Completion). To prove that taking over "is or will be delayed," the Contractor must show more than just that the occurrence caused the delay. According to the high court ruling in FIDIC-1987 ICC Case 10847 (2003) 48, "delay to an action or sequence of activity that is not important activities or critical are not sufficient to reasonably grant the Claimant an EOT." [16].

1.10 EGYPTIAN CODE FOR PROJECT MANAGEMENT

The code represents a summary of the experiences of workers in the construction industry that represents a reference for each party to avoid any disputes that may arise. Clause No. 4-5 -9 Project Change Management, states the following:

The project manager should do the following:

- Study the modifications and changes requested by the owner, or proposed by contractors, the designer consultant, Or members of the supervision team, and the possibilities of their implementation and their impact on various other implementation contracts at a time and cost.
- Study the conditions governing the amendments efficiently and effectively, take into consideration what may result from them and the Effects on cost and duration of implementation.
- Avoid, as much as possible, changes that affect the main project objectives.
- Follow the following procedures when studying each change
- Determine the technical importance, take into consideration the contractual consequence on cost and time, Review the cost and ensure that it does not exceed the permissible limit, and Approve all changes only through the change order systems specified by the project manager.
- Ensuring the comprehensiveness of the changes in all the technical details, and their instructions, to help in the accuracy of its technical and financial evaluation
- Recording day-to-day operations on the site, equipment usage rates, finances, and supplies and keeping them so that it is easy to refer to them in evaluating changes to the project.
- Submitting periodic reports regarding the cost of the project, including a part related to the changes, whether approved, that is, understudy or expected.
- Maintain a record of changes and claims in the project, and this record contains the estimated and final costs, which are submitted as reports at regular times.

- Change orders are issued from one source only, which is the project manager [17].

The Egyptian code gave good directions for managing change orders but

- 1- Ignoring the periods for each activity, without specifying a time for sending the study or claim
- 2- No suggestions or methodology have been developed in case of disagreement or procrastination in adopting the cost or duration of the additional time needed to change the order.

1.11 FIDIC PROCESS MODEL FOR CHANGE MANAGEMENT CONSTRUCTION

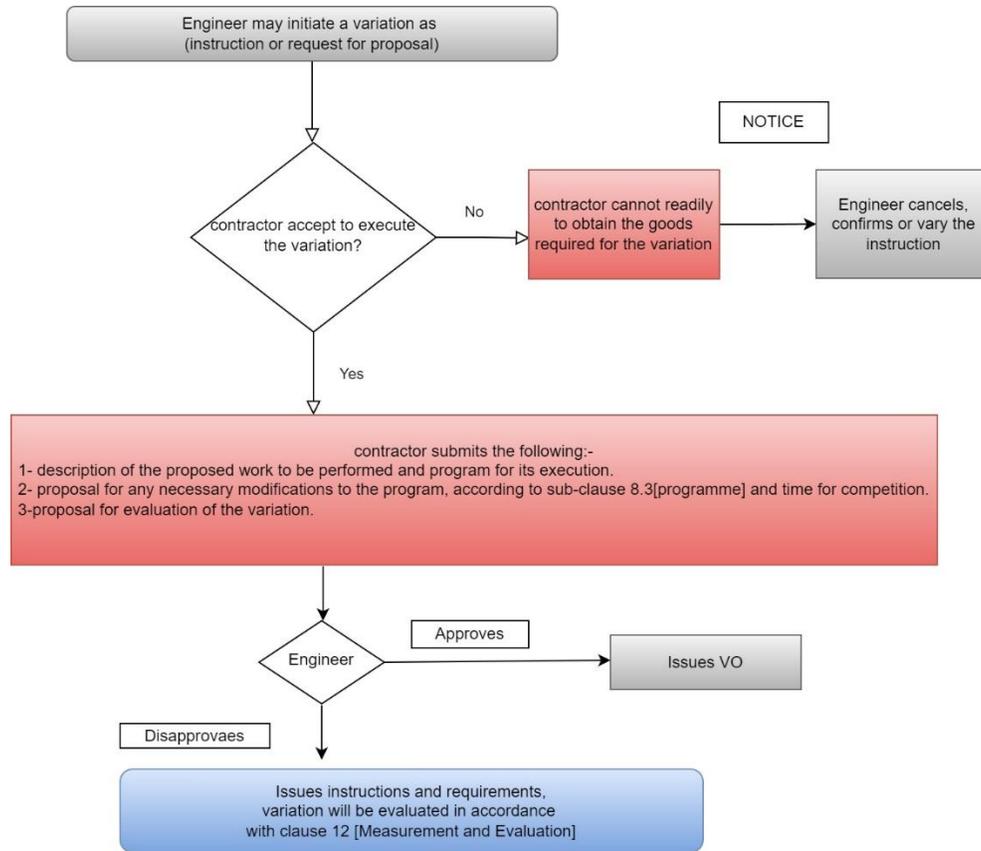


Figure 1. Summary clause 13 variation order in FIDIC red book [18].

2. FILED STUDY

This represents part of the applied research, which deals with what has been raised and deduced from the previous theoretical part, and explains that the change orders repeatedly in all projects must be developed in order to avoid access disputes, arbitration, judicial and otherwise. Selected contractor's first and second category to be the field of research and study where they have the right to participate in major projects so a purposive sampling strategy was selected. In the choice of the exact cases, Project budget “large” more than 50 Million-Project schedule “small” less than 3 years - Type of project (residential, admin, infrastructure). After sorting contractors, the number of contractors after the screening process is as follows:

- * (428) contractors' first category

* (311) contractors are the second category

To become the total number of contractors is (739) contractors.

2.1 Sample Size Calculator:

The sample size was estimated using this webpage [19]

Using a 95% confidence level and a confidence interval of 10, the result was 85 construction contractors.

85 contracting companies were approached through personal interviews and 40 companies responded and 15 companies refused to cooperate and 30 companies didn't give us useful answers this means that the response rate is 47 %.



Figure 2 . shows contractor interaction.

2.2 Designing a questionnaire to study the current situation of change orders management in Egypt:

The interview questions to contain the following questions:

The first section: contains an illustration to clarify its purpose and instructions about the questionnaire.

The second section: contains general information about the person answering the questions, such as the number of years of experience and his specialization.

The third section: Contains information about the contractor from years of experience, registration category, and specialization, to clarify the level of expertise among contractors participating in the field study.

The fourth section: discusses the change orders in terms of the size of the change during the implementation phase and its impact on disputes and risks.

The fifth section: discusses the management of change orders in Egypt and the extent of its deficiencies.

The sixth section: required from contractor to provide us with examples of a change order that he expose to it personally and how to deal with it to know the real problems to consider when making proposals.

2.3 Analyze the results of the interviews:

The most important and prominent questions that monitor and clarify the size of the research problem and its importance are as follows:

- What is the size of the change in construction projects during execution? The objective of this question: Ensure awareness of the respondent to the questionnaire to change orders during work. By answering this question, it is clear that change is something inevitable in any project, and Figure (3) shows that 48% of respondents confirm that the change ranges from 10% to 50%.

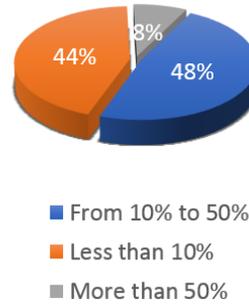


Figure3 . shows the size of variation during the implementation phase.

- Do the change orders lead to disputes? The objective of this question: is to make sure that there is a problem in the management of change orders in Egypt and to monitor the results of management and the possibility of disputes. By answering this question, it is clear that there are deficiencies in the management of change orders in Egypt and Figure (4) shows 60% of the answer confirms that the change orders lead to disputes.

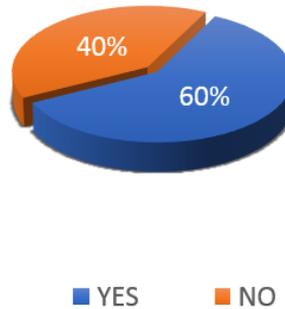


Figure4 . shows size of disputes because of variation.

- What is the size of the risks or burdens Taken by the contractor? The objective of this question: confirm the point of view of research that the contractor bears the greatest risk in the proportion of change orders. Through the answer to this question, it is clear that the contractor bears the risks and burdens of many resulting from change orders and Figure (5) shows 36% of the answer is that the contractor shall bear the burdens and risks of more than 10% and up to 50% because of change orders other than seeing 24% of the sample that the contractor bears more than 50%.

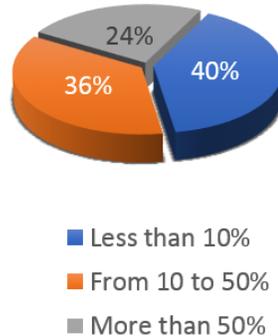


Figure 5 . shows the size of risk by a contractor.

- Is the agreement on price differences resulting from change orders before the start of implementation? The objective of this question: to see deficiencies in the management of change orders is because of the lack of agreement on the price differences. By answering this question Figure (6) shows 52% of the answer is that contractors do not agree on the price differences before implementation, and this leads to disputes.

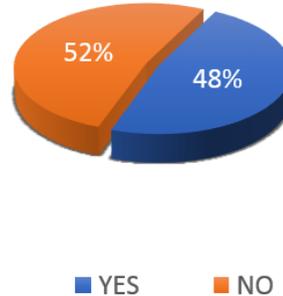


Figure. 6 Contractors' agreement on the price differences resulting from change orders before the start of implementation.

- Is the agreement on the additional time required to implement change orders before the start of implementation? The objective of this question: to see deficiencies in the management of change orders is because of the lack of agreement on the additional time required to implement change orders that cause disputes most of the time. By answering this question, it is clear that there are shortcomings in the management of change orders and Figure (7) shows 48% of the answer is that contractors do not agree on how long the additional orders required to implement the change before implementation, and this leads to disputes.

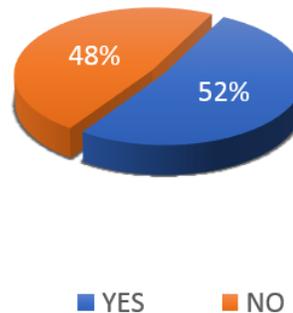


Figure7 . Contractors' agreement on additional time resulting from change orders before the start of implementation.

- From your point of view and practical experience in this area which are most tolerant to the risk of change orders? Please explain the reason for your choice of more parties tolerant of the risk of change orders. The objective of this question: make sure the hypothesis adopted by the research that the contractor is more tolerant of parties' risk with monitoring deficiencies in the management of change orders. Through the answer to this question, it is clear that the majority agrees with the hypothesis of the research, and figure (8) shows 80% of the answer is that the contractor supports more parties tolerant of the dangers of change orders.

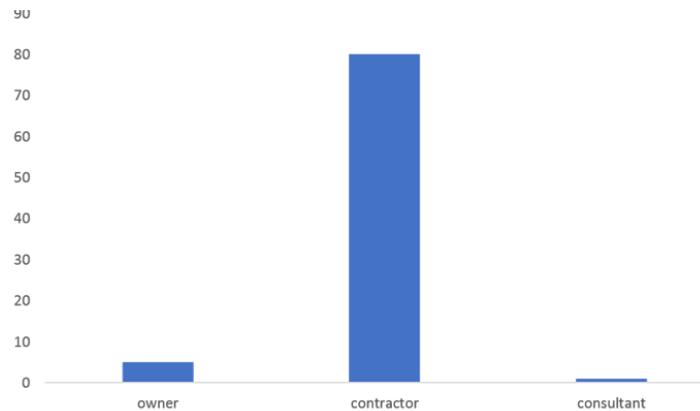


Figure 8 the extent to which the construction parties bear the risks of change orders

- Do you see change orders management in Egypt, needs to develop? By clarifying what can be added to the development of this administration. The objective of this question: Do you feel deficient in knowledge of the labor market experts in the current management of change orders and what are the reasons for their point of view are. By answering Figure (9) shows 88% of the answer agree that change order management in Egypt needs to develop.



Figure 9 change order management needs to develop

From the views of experts in the market the proposals that we are viewing and can guide future research it is as follows:

- There must be a government and one responsible neutral independent of the consultants to be neutral in the work.
- A committee should be formed to resolve disputes for change orders between the owner and the contractor.
- It is preferring to not putting the powers in one person 'hand.
- The contractor must have the right to accept or reject the implementation of the change order.

- The items of categories must be agreed on before the start of implementation.
- The additional period resulting from change orders must be agreed on before implementation.
- There must be a comprehensive study of the project in all respects during the subtraction stage to reduce change orders.
- Qualified engineers and designers must be selected to study the change orders.
- The owner's powers in change must be legalized all the time.
- There is should be general coordinator for changes in each project.

2.4 The most important finding of the survey to extract the state of change order management for government projects in Egypt

- The change in construction projects during the implementation phase ranges from 10% to 50% of the size of the project.
- Change orders during the implementation phase led to disputes by up to 60% in Egypt.
- The price differences resulting from change orders are not agreed on before the implementation by up to 52% of orders.
- 88% of the contractors say that change orders management during the implementation phase of government projects in Egypt needs to be developed.

3. Strategy to develop the current change order management during the implementation in Egypt:

This section achieves the main objective of the research which is, Develop the current change order management during the implementation of government projects in Egypt. And in order to achieve this goal at first we should discuss the problems of the current situation which were monitored in the previous chapter, and then comes to the solution to these problems through the deduced basis from the study of the international model contract (FIDIC) deal for change orders and the analysis it to use them in developing solutions and proposals that can be practiced in the short term under the current laws and the current conditions to avoid the weak points and the current problems and improve the current situation performance.

3.1 Discussing the problems of the current situation for managing change orders:

Through the previous theoretical study and analysis of its results and the deduced results from the field study, it becomes clear that there are problems in the current situation for administrating change orders, as follows:

- 5-1-1 The legal aspect of administrating change orders in Egypt.
- 5-1-2 Current construction contracts in Egypt.
- 5-1-3 During the implementation of change orders in Egypt.

3.2 The basis of development proposals according to local conditions of the governmental project in Egypt:

In general, there are two ways of change order management as follows [18]:

The first way: (Proactive way)

Define and expect the potential changes and design the solutions before the change occurs.

The second way: (response way)

And this way improves the efficiency of dealing with the change after it occurs.

And this was introduced in the third chapter by studying the model of international contract (FIDIC) which will be used in laying the basis that shows a strategy to develop the current situation.

3.3 The development proposals for the current situation to manage the change order in the governmental projects in Egypt:

Suggested solutions have been presented to develop the current situation of change order management in a proactive way and response way:

- Proactive proposals:
 - The design phase takes more attention, time, and follow-up.
 - General standard conditions in construction contracts.
 - The competent authority.
 - Value Engineering.
 - Commissioning administrative or people to follow up on the change order.
 - Improve the process of the requested documents for the claims.
 - Full awareness of the contract by the site's team.
- Response Proposals
 - The Estimation of the additional time of the change order
 - Possible solutions
 - The Escalation
 - The Equitable settlement

4. FINDING AND RECOMMENDATIONS

1. The change orders are inevitable during the implementation phase in all government projects in Egypt.
2. The change in construction projects during the implementation phase ranges from 10% to 50% of the size of the project.
3. Change orders during the implementation phase led to disputes by up to 60% in Egypt.
4. The consequences of change all the parties to the project, but the largest share of the contractor up to more than 50% of the effects.
5. There are no alternative solutions in the contract or the law if the two parties do not reach an appropriate joint agreement regarding the change order.
6. Non-competitive pricing of change orders, as it is outside the scope of the contract and is not subject to the competitive spirit and at a later time to the date of the study.
7. Oral change orders without documents.
8. Delay in obtaining approval from the owner of the change order, due to the fear of subsequent claims to the change order.
9. Postponing the resolution of many change orders at the end of projects, the project manager usually delays the conversations awkwardly to the end of the project and thus the facts surrounding the change order become memories in addition to the lack of documents sometimes, and change orders are settled on parts of their original value.

Search is also recommended for the following:

1. Using 4D and 5D models of the project and presenting them to the owner before the start of implementation to help visualize the project and make any required modifications to the design before the start of implementation.
2. It must be clear and specific to those who can agree to what and any extent, through the administrative authorities, and also expressly remembered in the contract documents.
3. Change order to be written and dated so that it is considered to be in arbitration.
4. Increasing the period of the tender to give the contractor time for proper study.
5. Doing studies to develop the legal aspect of managing change orders during the implementation phase in Egypt.

6. Involve all parties in the early time for variation in order to choose the best solutions and approval.

REFERENCES

- [1] A. A. S. a. I. P. A. Wiguna, "Analysis of the category of variation order in x project at XYZ ltd," in IOP Conference Series: Materials Science and Engineering, 2020.
- [2] M. E. S. H. A. Hasan A. Thani, "IDENTIFICATION AND ANALYSIS OF MAIN REASONS OF VARIATION ORDERS," in International Conference on Civil and Architecture Engineering, cairo, 2018.
- [3] Y. L. S. S. Henri Desyardi, "Guidelines for effective Variation Order determination," in IOP Conf. Series: Earth and Environmental Science, 2019.
- [4] E. Alia Alaryan, "Causes and Effects of Change Orders on Constuction Projects in Kuwait," Intrnational Jornal Of Engineering Research and Applications, pp. 1-8, 2014.
- [5] P. Arain, "The potential effects of variation orders on institutional," Facilities, pp. 496-510, 2005.
- [6] A.S.Alnuaimi, R.A. Taha, M. Al Mohsin,A.S. Al Harthi., "Causes, Effects,Benefits, and Remedies of Change Orders on Public Construction Projects in Oman.," Journal of Construction Engineering and Management, pp. 615-622, 2010.
- [7] L. Arain, "Causes of Discrepancies Between Design and Construction," Architectural Science Review, pp. 237-249, 2004.
- [8] A. A. R. . M. N.Mohammad, "Investigation on the causes of variation orders in the construction of building project," Journal of Building Performance, 2010.
- [9] P. Keanne, B. Sertyesilisik & A.D. Ross, "Variations and Change Orders on Construction Projects," Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, pp. 89-96, 2010.
- [10] I. M. H. A. H. Memon, "Significant Causes and Effects of Variation Orders in Construction Projects," jornal of applied sciences, Engineering and Technologyn, pp. 4494-4502, 2014.
- [11] F. A. . S. A.-R. Adnan Enshassi, "Causes of variation orders in construction projects," Journal of Civil Engineering and Management, pp. 540-551, 2010.
- [12] R. Ndiokubwayo, An analysis of the impact of variation orders on project performance, Cape Peninsula University of Technology, 2008.
- [13] O.O.Obideyi, Major Causes & Effects of Engineering Change Orders On Nigerian Petroleum Industry Projects, Nigerian: Heriot-Watt University, 2010.
- [14] K.-R. . N. P.A.Koushki, "Delays and cost increases in the construction of private residential projects in Kuwait," Construction Management and Economics, pp. 285-294, 2005.
- [15] و. المالية، "قانون رقم 182 لسنة 2018 بشأن تنظيم التعاقدات التي تبرمها الجهات العامة"، الوقائع المصرية، 31 أكتوبر 2019.
- [16] FIDIC Red book, 2017.
- [17] ا. الدائمة، "الكود المصرى لإدارة مشروعات التشييد كود رقم 311"، وزارة الإسكان و المرافق و التنمية العمرانية، 2009.
- [18] "Viewpoint," [Online]. Available: <http://www.viewpoint.com/>. [Accessed 20 6 2022].
- [19] "survey system," [Online]. Available: <https://www.surveysystem.com/sscalc.htm>. [Accessed 27 12 2021].