Evaluation of Change Management Efficiency

Of

Construction's Contractors

By

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"I declare that this Master's report is the result of my own research except as cited in the references. This report has not been accepted for any degree and is not concurrently submitted in candidature of any degree."

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Date :

“Dedicated to my parents, the first to teach me,

To my wife for care and support,

And to my children, RITAJ and MALIKA

With a hope for a bright future”.

Mohamed Anees

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ABSTRACT

This research is targeted at providing a deeper insight into the change orders (CO) in the large building construction projects according to the different parties involved (owner, designer, consultant and contractor) with respect to the Egyptian industrial construction sector. The focus is on the causes of change orders, the effect of changes on a project, and the efficiency of the control procedures adopted.

The subject is treated in three parts. The first part covers a review of literature discussing the subject of change orders. The review includes major periodicals, research reports, and some text books. The information and recommendations made in this part were used to develop and establish direction for the second part of the study.

The second part is a field survey for over seventy experienced entities involved in construction and consultancy of large building projects. Data gathered was streamlined and analyzed using computer statistical package (STATSTICA) .The results of the survey is presented in five areas; the general characters of the companies and market, the causes, the effects, the efficiency of the control procedures of change order.

The third and final part evaluates the change order's control for selective samples of contractors and investigates their change management efficiency by applying an evaluation check list based on a suitable criteria selected for evaluating change management efficiency.

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INTRODUCTION

1.1. Introduction

Delays in completion, over spending and quality defects are common problems besetting the project delivery process in the construction industry.

Project delays and overspending are not automatically the fault of the project team. In many cases, delays are often caused by the client requirement changes that result in a different specification of work. However, re-work, whether at the design stage or the on-site stage, is usually pure waste, and should be avoided.

1.2. Problem statement

Changes in construction projects are very common and likely to occur from different sources, by various causes, at any stage of a project. It may have considerable negative impacts on many items such as costs and schedule delays. It can also affect labor productivity. A critical change may cause consecutive delays in project schedule, re-estimation of work statement, and extra demands of equipment, materials, labor, and overtime. Changes, if not resolved through a formalized efficient change management process, can become the major source of contract disputes, which is a severe risk contributing to project failure.

1.3. Aim and Objective of Study

Based on the problem statement above, the aim of the study is to mitigate and reduce, if not nullified, the issuance of variation orders during the implementation of construction projects.

Following from the aim of the study, the main objectives of this study are:

- To identify types of change and the most important causes of change in construction projects
- To determine the Change impact on construction projects.
- To evaluate the efficiency of the change management process through the construction contractors organization.

1.4.Scope and Limitation of Study

The scope would be too large to tackle. In order to achieve the above objective, the study has confine itself to Construction projects mainly major ones.

The scope of this study is confined to:

- Construction projects undertaken by the main contractors in Egypt.
- Data collected are from capital projects within Egypt.
- The respondents comprised construction project managers and contractors carrying out most of the construction projects.
- Projects managed by the Project Management firms in Egypt .

1.5.Research Methodology

In this study, the methodology used in conducting this research consisted of the following tasks:

- Conduct a literature search to define the objectives.
- Conduct a data gathering process. The collected data are mainly concerning the construction experts' point of view regarding the change order's causes, effects and impacts in addition to construction project data about the changer orders.
- Conduct a data analysis process. The main points involved in such analysis are most significant causes of the change order and the highest impact that raised due to the change

- order in addition to the highest ranked parameters for the management of the change orders.
- Investigate the change management procedures for some case studies.

1.6. Thesis organization

Briefly, the study is divided into six chapters, where Chapter one discussed on the problem statement, objectives, scope and limitation of the study and brief methodology adopted to achieve the objectives of the study.

Chapter two discusses the principle, causes of variation order and its impact as found and presented by other researches in the industry. A comparison of contract clauses widely used in the local construction industry is also included.
The understanding of the principles of variation orders in Chapter two is used as a base for the data collection presented in chapter three

In Chapter three, the data collection including target group, questionnaire design and analysis method were presented.

In Chapter four, the collected data from the questionnaire survey is analyzed and discussed. The findings of the causes and effects of variation orders on selected projects is presented and discussed

Chapter five, four projects were selected for evaluation regarding the management efficiency for the change management.

Lastly, Chapter six, which conclude the findings from both the case study and questionnaire surveys. Suggestions to mitigated and other future measures are presented.

CHAPTER TWO
LITERATURE REVIEW

Chapter Two
Literature review

2.1 Introduction

Decisions are made every day in construction processes based on incomplete information, assumptions and the personal experience of the construction professionals that might lead to change and or rework. *Moonseo (2002)* reported the difference between rework and change, both change and rework are done in the form of either 'adding', 'deleting' or 'replacement. However, given the same problem, they have different behavior Patterns. In construction, the change option is more general. Since construction has a physical manifestation, construction rework is usually accompanied with the demolition of what have been already built, which normally has a bigger direct impact on the construction performance than the change option.

In construction projects, changes are very common and likely to occur at any stage of a project. It may have considerable impacts on many items such as costs and schedule delays. Managing changes effectively are crucial to the success of a construction project.

There have been numerous articles written on changes, change orders and change management in construction. Most of the articles written discussed the legal aspects of changes such as claims and disputes. Many other articles were devoted to the discussion of the effects of changes on labor productivity (*Al-Dubaisi 2000).*

The objective of this study is to evaluate change management efficiency within the contractor organization. To make accomplishment of this goal easier, this chapter will shed a great deal of light on the different aspects of construction changes.

In this study, the literature review section is divided into six parts; the first part discussing the different definitions of changes and their basics, the second part covers the types of change, the third part discuss the change order legislation, the fourth part investigates the causes of change, fifth part explains the aspects of the change (its impact) and the sixth part concentrates on control, administration of the change procedures.

2.2 Definition of changes

A construction contract is a business agreement that is subject to a great variability. Most contracts make provisions for possible variations given the nature of building construction (*Finsen 2005*) and (*Wainwright et al.1983)*.

A degree of change should be expected since it is difficult for the clients to visualize the end product they procure (*Love 2002).* Unforeseen conditions may arise which require measures that have not been provided for in the contract (*Finsen 2005).* These changes are commonly referred to as change orders, variation orders, bulletins, field changes, field work orders, field memorandums, and field directives. "Change Order(s)" is the commonly used expression, especially in Construction, to designate any change or variation from the original scope of the construction contract (*Assem 2000).*

Many contractual clauses relating to changes allow parties involved in the contract to freely initiate variation orders within the ambit of the scope of the works without alteration of the original contract. Variation orders involve additions, omissions, alterations and substitutions in terms of quality, quantity and schedule of works (*Finsen 2005).*

A Field study made by *Ndihokubwayo and haupt (2009)* over 30 companies obtaining an equal representation in a stratified sample of contracting, cost consultant and architectural companies shows that ; Almost all respondents (86.9%) acknowledged that complex operations led to variation orders. More than a half of respondents (51.9%) reported that most variation orders could be avoided.

Al-jishi and Al Marzough. (2008) simply defined the Change as any deviation from an agreed upon well-defined scope and schedule. Stated differently a change is any modification to the contractual guidance provided to the contractor by the owner or owner's representative.

Later *Oracle (2009)* agreed with *Al-jishi et al. (2008)* on the definition of the project change as the difference between the contract requirements as a set forth in the original agreement between the parties (often as established at the time of bid) and the requirements imposed subsequent to this agreement

(usually recognized during the actual construction of the project). That change order requests may occur in many forms; oral or written, direct or indirect, externally or internally initiated, and legally mandated or optional (*The PMI's guide to project management body of knowledge (2009).*

2.3 Types of changes

Classifications of the changes in general terms apply to the changes in construction domain. Changes can be classified in many different ways depending on the form, value, rate, time, kind, stage, effect of classifications.

2.3.1 According to form:

Most researchers classified the different types of change orders into the following five categories (O'Brien 1998);

a) Bilateral: agreed upon by both parties and hence reducing the risk of disputes or claims.
b) Unilateral: ordered by the owner and carried out by the contractor in accordance to the relative contractual clauses. Disagreement not only will increase the risk of claims but also of job non-completion.
c) Formal: given to the contractor in written format that guarantees the contractor right to perform change work within the general scope and to appeal for equitable adjustment.
d) Informal: also called constructive, given to the contractor in an oral format mainly as a result of defective specification.
e) Cardinal: a change order or a series of change orders beyond the scope of the contract. The failure to perform them would not constitute a breach of contract.

2.3.2 According to value:

Two types of variation orders were introduced, namely beneficial and detrimental variation orders. A *beneficial variation* order is one issued to improve the quality standard, reduce cost, schedule, or degree of difficulty in a project, it is a variation order initiated for value analysis purposes to realize a balance between the cost, functionality and durability aspects of a project to the satisfaction of clients. A *beneficial variation* order eliminates unnecessary costs

from a project; and as a result, it optimizes the client's benefits against the resource input by eliminating unnecessary costs. While *detrimental variation* order is one that negatively impacts the client's value or project performance. (*Arian and Pheng 2005)*. Arguably, a detrimental variation order compromises the client's value system. A client who is experiencing financial problems may require the substitution of quality standard expensive materials to sub-standard cheap materials.

2.3.3 According to rate of change:

A change that occurs during a project can be a “gradual change” or a “radical change”, depending on the degree of severity (Sun et al.2006). A *gradual change*, also known as *incremental change*, happens slowly over a prolonged period and its intensity is low. While the *radical change* is a sudden, dramatic and has a marked effect. *Gradual changes* often occur during the design development stage, where many decisions are fine-tuned and refined progressively. *Radical changes* occur more often at post fixity or post design development phases.

2.3.4 According to time:

Project changes can also be classified as “anticipated changes” and “emergent changes”. *Anticipated changes* are planned in advance and occur as intended. On the other hand, *emergent changes* arise spontaneously and are not originally anticipated or intended (Sun et al. 2006).

2.3.5 According to kind:

Huang et al. (2007) and Levy (2006) reported that most researchers distinguish three kinds of changes: rework, change order, and Construction Change Directive (CCD) .

Rework refers to re-doing a process or activity that was incorrectly implemented in the first place and is generally caused by quality defects, variance, negligence, and poor design and/or on-site management (Sun et al. 2004). Rework is usually pure waste and should be avoided as much as possible.

Change order refers to changes that are generated by unanticipated causes, for example, scope changes from the owner, design / technological changes from the architect, and cost and/or time changes caused by

supplier problems, design errors, material and operational failures, or by unsatisfactory site conditions. Change orders are common to most projects, and very common with large projects (*Hao et al. 2008).*

A CCD is issued by an owner or its designate requesting a change in the contract scope when there is number agreement on cost. CCDs are originated from disputable change orders and could become change orders again, once the dispute can be settled *(Hao et al. 2008).* Fig. 2.1 shows the relationship of change orders, reworks, and CCDs.

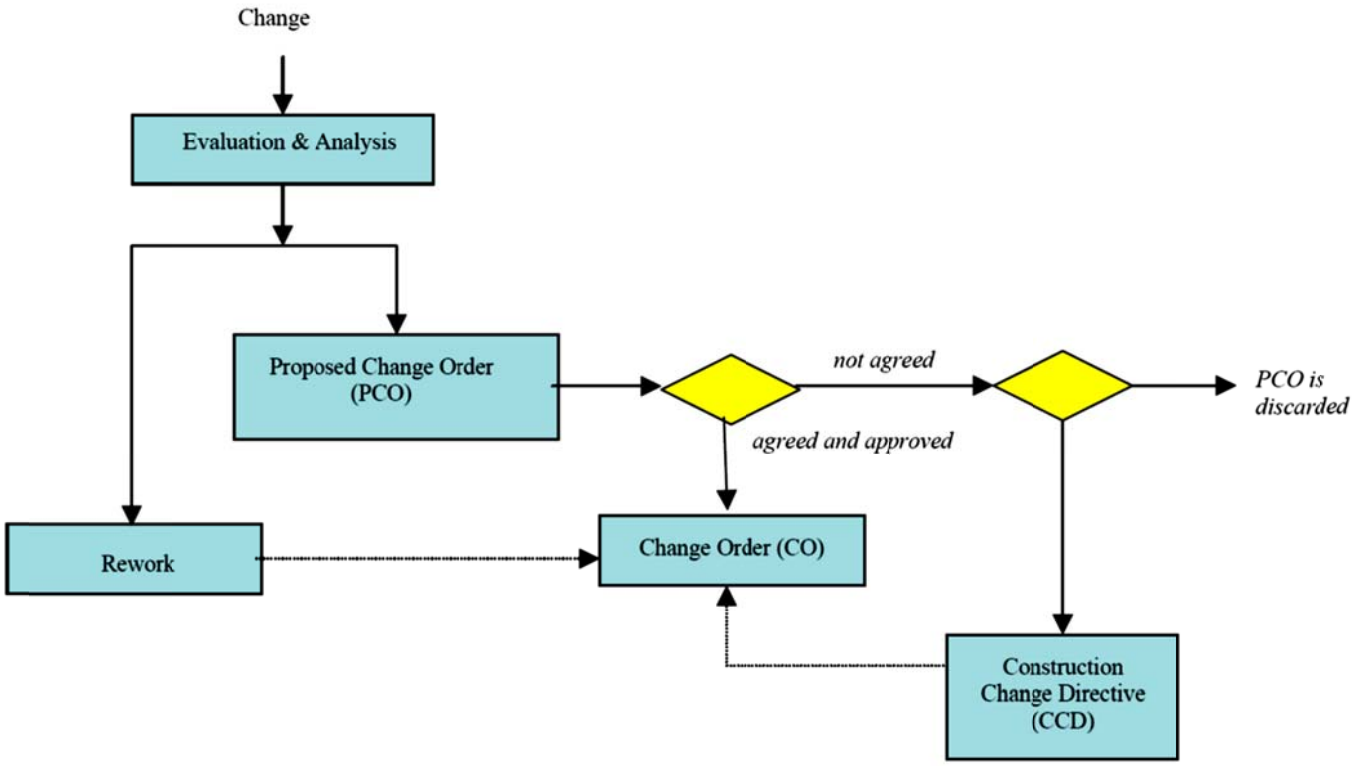


Fig.2.1 Change orders, reworks, and CCDs

2.3.6 According to stage:

the best classification is to discuss changes in the context of typical stages/phases in a construction project. Table 2.1 summarizes stages, sources and impacts of construction changes prepared by *Hao et al. (2008).*

Table 2.1: Summary of construction changes

Stage	Stakeholder	Types of changes	Impacts	Actions
Specification	Owner/Client/User or architect	Changes to requirements including specification, scope of projects, design brief, etc.	Changes in design and construction processes	Carefully provide detailed specification documents before bidding.
Design	Design/engineering Consultant	Incomplete/inconsistent drawings; design error/defect; design change; omissions of site conditions and buildability; changes in codes and regulations	Rework of design and drawing; rework in construction; change orders	Better control of design versions, drawings; site investigation; consider buildability in design
Construction	Contractor/sub-contractors	As-builts not confirm with as-design; quality defect; unanticipated site conditions; value engineering; materials or equipment not available; inclement weather	Rework; change orders; changes in design	Quality control; site operational control; coordinated documents and drawings; daily logs

2.3.7 According to net effect over scope:

Al-jishi et al. (2008) & *Al-Dubaisi (2000)* classified the change order in accordance to net effect over scope to :

- Additive change (e.g. addition to the original scope)
- Deductive change (e.g. deletion of work or shrinking the scope).
- Rework-due to quality deficiency
- Force majeure change

2.3.8 According to the procedure used to introduce them:

Oracle (2009) categorized changes as either directed, constructive and Cardinal changes; *Directed changes* are changes that are directed by the owner and are, therefore, understood by the owner to be a change to the contract.

Subject always to the specific requirements of the contract, examples of directed changes include;

- Addition or deletion of work
- Revision to material specifications
- Revision to project phasing
- Change to site access or hours of operation
- Change to contract duration

Constructive changes typically result from the actions or inactions of the owner, and usually are not intended or recognized by the owner to be a change. Subject to the specific requirements of the contract, constructive changes might include

- Failure to disclose material information
- Impossibility or impracticality of performing the work as designed
- Slow turnaround of submittals and requests for information
- Untimely inspections

Cardinal change is a change that has the effect of making the work to be performed fundamentally different from the work the parties agreed to when the contract was bid and awarded (*Oracle 2009).*

Summarizing the classification of change :

Based on type; change could be bilateral or unilateral, formal or informal and cardinal. Based on value; change could be beneficial or determinal. Based on time; change could be anticipated or emerged. Based on kind; change could be rework, change order and construction change directive. Based on stage; change could be additive, deductive, rework or force majeure. Based on procedure used; change could be directed, constructive or cardinal .

2.4 Change order legislation

2.4.1 Introduction

Construction is not like assembly line production where the same item is produced over and over again. Rather, almost every construction project contains a unique design of some complexity or a standardized design applied to a different location and under unique conditions. In all likelihood, the parties to the contract have not built precisely the same building before so they do not know what project specific problems will be encountered, *(Hadad 2009).*

Moreover, few, if any, construction projects are completed without some deviation from the original plans and specifications. Such deviations, to some degree, are expected. Consequently, the parties want to reserve the right to make adjustments as construction progresses and unexpected issues arise on the project. A contract change happens when an event or condition modifies work a certain element as defined in the contract documents, *(Cushman et al. 2001)*.

Changes in the work are typically handled through a process known as “change orders.” These arise in situations where the parties must modify the contract to address additional work outside the scope of the original contract, or address plan deficiencies or changed site conditions or any other situation in which one party is claiming that the scope of the work has now changed to such an extent that a change to the contract, *(Ahlers 2007).*

The objective of this section is to the change order clauses in focus on different contract types.

2.4.2 Change in work

The “changes” clause is a necessary provision in every construction contract, and most construction contracts have a changes clause permitting the parties to make changes in the scope or character of the work. Typically, construction contracts contain clauses which allow for such changes either with or without the agreement of the parties at the time the change is made *(Ahlers 2007).*

The traditional changes clause requires mutual agreement of the parties on the scope of the modification as well as the effect of the modification will have on the price for the work and the time in which it will be performed. This method results in what is generally referred to as a “change order.” In theory, the change order should be a written document issued prior to commencement of the work. However, in reality, this rarely happens. *(Ahlers 2007)*

The second type of the changes clause applies when the parties cannot agree on some portion of the modification, either as to the need for a modification, the scope of the modification, or the price or the time impact of the modification. Under this scenario, the changes clause permits one notwithstanding the lack of the agreement between the parties as to the impact of the modification.
The manner in which the contract addresses the scenario where the parties are not in agreement and the name of that process vary from contract to contract. However, change clauses typically will provide some mechanism for one party to require that the added or disputed work be performed, as well as provision for an adjustment at a later point in time to resolve the attendant price and time issues. As might be expected, this type of change is the subject of much litigation. The owner or contractor has secured performance of the change with number agreement as to price or time. This leaves the contractor or subcontractor to negotiate after the fact a fair price or time extension. *(Ahlers 2007).*

2.4.3 Contract provisions

In the following section, the researcher will present the construction contracts provision regarding the work change or any variation and alternations for the international and local construction laws.

2.4.3.1 International construction law;

For the international laws, the researcher choose the FIDIC (the International Federation of Consulting Engineers), which is the international organization responsible for the preparation of standard forms of construction contract. Considered to be the most popular and usable, the most accepted among all the entities in the construction industries.

The researcher choose the most Traditional FIDIC Forms of Contract "*Conditions of Contract for Works of Civil Engineering Construction Fourth Edition 1987* ", the red book and "*the Suite of Standard Conditions of Contract _Conditions of Contract for Construction - design by Employer : The Construction Contract 1999 Edition, the New Red Book* ". Although both still applicable, there is a substantial difference between them.

2.4.3.1.1 FIDIC 1987 OLD RED BOOK

Change in work relay under clause number 51 and 52, each clause is divided into sub clauses, defining the change, who is authorized for issuing them and the control procedures. Clause 51 is referring to Variations, Alterations, Additions and Omissions. The changes is defined under the clause by any increase or decrease the quantity of any work included in the Contract, omitting any such work, change the character or quality or kind of any such work, change the levels, lines, position and dimensions of any part of the works, execute additional work of any kind necessary for the completion of the works, or change any specified sequence or timing of construction of any part of The Works. Sub clause 51.1 assign the project engineer as the entity responsible for issuing the change orders. *(Conditions of Contract for Works of Civil Engineering Construction Fourth Edition 1987).*

While clause 51.1 define the type of change and who is responsible for issuing it, clauses 51.2, 52.1, 52.3 & 52.4 explaining the control procedure, change order cost impact reference and basics including cost breakdown analysis , documents needed, time cycle for the change order. The Clauses committed that contractor shall not make any such variation without an instruction of the Engineer and to start proceeding with the change order as soon as receiving the instruction despite the impact agreement, *(Construction Contract FIDIC 1987 Edition).*

2.4.3.1.2 FIDIC 1999 NEW RED BOOK

Change in work relay under clause number 13 "Variations and Adjustments", one of the main difference between the two edition is the right to vary which means that the contractor has the ability to notice the engineer stating that the contractor cannot readily obtain the goods

required for the variation, or such variation triggers a substantial change in the sequence or progress of the Works. Upon receiving this notice, the engineer shall cancel, confirm or vary the instruction, *(Construction Contract FIDIC1999 Edition).*

Sub Clause 13.1 defines the types of the variation same as old red book, while other clause 13.3 defines the variation procedures including execution. The new red book allows the contractor to propose for the evaluation of variation (its impact over cost and schedule) for approval.

Comparing the two FIDIC editions, It was concluded that the new red book modify some clauses against the owner and the engineer to the contractor that is why most of the contracts used up till now follow the old FIDIC *(Hadad 2009).*

2.4.3.2 Local construction law :

In many Arab countries, the implementation of large construction projects, including state enterprises, executed according to the FIDIC, whether a foreign language (usually English), or in Arabic (translated from foreign language), after making some adjustments. In Egypt, the contracts issued by the Housing and Building National Research Center (HBRC) of specifications to the terms of the Egyptian Public Workers, "the general conditions of contract construction works of the fifth edition in 2004". Which is considered the only official form of construction contract that is used beside the FIDIC; regarding the variation they are almost the same, *(Hadad 2009).*

While in other countries, the researcher will demonstrate two wide spread types used, extracted from the Washington Construction Law and American Institute of Architect (AIA),

2.4.3.2.1 Washington Construction Law:

I. <u>Changes clause;</u>

The majority of construction contracts include a "changes" clause giving the project owner the unilateral right to order changes in the contract work during the course of performance. Absent a changes clause, a modification of the contract must be agreed to by both parties and cannot be done unilaterally, *(Cushman et al. 2001).* In exchange for the owner's

right to order unilateral changes, the contractor is promised a price adjustment if the change increases the cost or time of performance.

1. Typical Changes Clauses

It is customary for such clauses to provide that for the contractor to be entitled to payment for the performance of such "changed work," the contractor must obtain a written change order signed by the owner and/or the architect prior to performance. One common problem is whether the contractor may recover for extra work performed where it failed to obtain a written change order. A second problem is, after change order approval, can the contractor use that change as a basis for an impact claim ?, *(AIA-201A 1997) and (Federal Acquisition Regulation 2005) .*

2. Purpose of the Changes Clause.

As per *Federal Acquisition Regulation (2005)* ,The four major purposes served by changes clauses are:

1) To provide operating flexibility by giving the owner the unilateral right to order changes in the work, to accommodate advances in technology and changes in the owner's needs and requirements.
2) To provide the contractor means of proposing changes to the work, thereby facilitating more efficient performance and improving the quality of contract end products,
3) To furnish procurement authority to the contracting officer to order additional work within the general scope of the contract without issuing the procedures required for "new procurement" or utilizing new funds,
4) To provide the legal means by which the contractor may process claims through the contract disputes process.

II. LIMITATIONS ON THE OWNER'S RIGHT TO ORDER CHANGES

There are limitations on the power of the owner to order changes. The person or persons ordering the change must have the requisite authority to issue the change order and the changes clause, which usually limits such orders to those "within the general scope of the contract," must encompass the proposed change. In public contracts, the use of the clause is further limited as a result of competitive bidding*, (Cushman et al. 2001).*

1) *Authority to Issue Change Orders*

The contract documents generally delineate the authority to issue change orders. AIA Article 7.1.2 requires that the owner, contractor, and architect all execute a change order. In U.S. government contracts, the contracting officer may unilaterally order a contract change.

2) *Cardinal Changes*

A potential problem with the grant of such broad authority under the changes clause is that the unscrupulous owner could order substantial changes to the construction project and still compel the contractor to perform. The law provides the contractor with relief in such situations. Federal and state courts have developed the “cardinal change doctrine”, which prohibits the owner from ordering changes outside the general scope of the contract. Where the work ordered is outside the scope of the contract, it is not legally a change but is extra work, and the contractor is justified in declining to perform it, as this work was not contemplated by the parties when they executed the contract. (*Cushman et al.2001).*

Faced with a cardinal change, a contractor has two options. It may perform the change and seek breach of contract damages after completing the work, or it may refuse to perform and claim breach of contract. If the contractor performs the changed work, it can suffer severe financial hardship until it proves and recovers breach of contract damages. If the contractor opts not to perform, and the change is ultimately found not to be cardinal, the contractor will have committed a breach of contract because it was obligated by the disputes clause to perform all of the original scope of work and all non-cardinal changes, *(Simon 1989).*

III. WRITTEN CHANGE ORDER REQUIREMENT/ORAL CHANGE ORDERS

Typical change order clauses provide that a contractor's failure to obtain a written change order before proceeding with the changed work may jeopardize or entirely foreclose recovery of the extra costs. The purpose of the requirement is that the extra or changed work not to proceed without a written approval. As to avoid later disputes wherein the owner claims that, the alleged extra work was part of the original contract. Further, that had the owner known that the contractor believed otherwise, the owner would not have ordered the performance of the alleged change, or would have ordered that the work performed in a different or less expensive manner *(Cushman et al. 2001).*

2.4.3.2.2 The American Institute of Architect;

The AIA forms articulate elaborate procedures for change orders. The AIA A201 includes change clauses allowing for three types of changes: change orders, construction change directives, and orders for minor changes in the work. These same procedures are incorporated into the AIA A401 by reference to the AIA A201.

i) AIA A201 provides:

Item 7.1.1 Changes in the work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work... AIA A201 describes change orders as follows:

Item 7.2.1 A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor and Architect, stating their agreement upon all of the following:

1) Change in the Work;
2) The amount of the adjustment, if any, in the Contract Sum,
3) The extent of the adjustment, if any, in the Contract Time.

To recover on a change order pursuant to this contractual provision, all parties must sign and agree to each of the essential elements of

the change. Until all required parties sign the change order, a contractor or subcontractor may perform the changed work but is at risk that the party to be charged with responsibility for the changed work will not agree to the terms for its performance.

2.5 Difference in perceptions

Arain and Pheng. (2006) conducted a study that focused on the points of view of developers of potential causes of variation orders suggested four main root agents of variation orders. These agents included clients, consultants, contractors and unspecified “others”. (*Ndihokubwayo and haupt. 2009)* performed a field study to identify the frequency of the involvement of these four origin agents of variation orders; the client or owner was the origin agent most frequently Involved, followed by consultant then Contractor and finally Others.

In order to minimize variations during detailed design and construction, owners should expend more effort (such as site studies) in the early development of the design. Perhaps, the most important step in the development of a variation order are the scope definition step. First, the original scope should be clear and well defined to distinguish between a variation of scope and a variation due to design development. A poorly defined scope does not provide a clear baseline against which variations can be evaluated as being either variations within or outside of scope, (*Jawad et al. 2009).*

We have to realize that communication between the parties is likely to be harmful even though owners and contractors may gradually realize that the project changes are reasonable. In other words, the change may arise disputes between owners, contractors and subcontractors. (*Chen and Hsu.2007*).

2.6 Causes of changes

Giving a well-structured schedule of works, maximum project performance would be achieved if the work invariably flows smoothly within time limits and anticipated budget constraints. However, it is rare that projects perform precisely in line with their original schedule due to reasons such as, for example, business condition changes, delivery slips, and corrections to design. (Al-Hakim 2005).

A degree of change should be expected as it is difficult for clients to visualize the end product they procure, (*Love and Lee 2000). Ssegawa et al.(2002)* asserted that the presence of variation clauses in the contracts amounts to admit that number project can be completed without changes. Arguably, variation orders cannot be avoided completely (*Mohamed 2001)*. *Ssegawa et al. (2002)* added that it is hardly possible to complete a construction project without changes to the plans or the construction process itself due to the complexity of construction activities.

Various authors intimate that variation orders are common to all types of projects, (*Thomas et al. 2002) and (Oladapo,2007).* So Even if carefully planned, it is likely that there will be changes to the scope of the contract as the work progresses*. (Harbans 2003).*

Another far later Field Study Survey made by *Ndihokubwayo and Haupt.(2009),* over 30 companies shows that; more than half of respondents acknowledged that complex operations led to variation orders. Fifty four point six percent (54.6%) admitted that the existence of a variation clause was an aspect that encouraged clients and/or consultants to change their minds during the course of a project.

To identify the causes of change, we have to identify the initiator of a variation order*. Arain and Pheng. (2006)* identified four origin agents of variation orders. These included "client', "engineer", "contractor" and "others".

- Client or Owner may request or order a change, usually scope change.
- Engineer may originate a change because of differing site condition or new governmental regulation.
- Contractor may initiate a change due to design errors, value engineering, or field requirement.
- Project management firm/person may originate a change, usually in schedule.

The level of owner involvement is expressed in terms the stages he get involved in the process of design and construction of the project. Forty one point 2 percent (41.2%) said that the owner gets involved in both design and construction stages. Twenty one point six percent (21.6%) said that the owner

gets involved in the design stage only. Thirty seven point two percent (37.2%) indicated that the owner gets involved in the construction stage only. It was noted that all the causes are originated either by the owner or by the designer/consultant, forty seven percent (47 %) originated from Owner and forty two percent (42%) from the designer *(Al-Dubaisi,2000).*

Despite the initiator of causes, variation orders occur due to a lot of reasons ranging from finance, design, aesthetic, geological, weather conditions to feasibility of construction, statutory changes, product improvement, work quality, work conditions or scope changes. Discrepancies between contract documents (Uyun 2007).

Meanwhile, changes that have been already made can be the source of subsequent changes in other tasks. For example, changes in the design work that have been made by mistake can cause subsequent changes in construction.

Based on a field study done by *Anadol and Akin. (2000)* about the reasons for the change order items, he developed eight categories for the reasons of change:

- The category of incomplete as-built drawings refers to the changes caused by inadequate or missing information because the as-built drawings of the building were incomplete.
- The category of design errors refers to errors of omission, errors of commission and the combination of the two made by the designers during the design phase of the project. There are yet other subcategories these three can be broken down into but within the scope of this study, we will only be referring to the main design errors category.
- The third category, site conditions, refers to the unforeseen conditions that were discovered during construction. This is distinct from the "as-built" category as it involves aspects of use and equipment installations not normally included in as-built drawings.
- The fourth category, user requests are mainly changes in the scope of work requested by the user of the building or space that was being constructed. This category includes the cases where the user makes a

change in his decision about the scope of the work or requests some part of the design to be demolished and reconstructed.

- Changes in scope, is the collection of changes that were often initiated by the project manager. Such changes include repairing the damage done by others, extra work needed in anticipation of future additions, and improvements of performance of the facilities.
- Contingency, refers to anticipated additional work and for which necessary funds were allocated at the time the contract was prepared.
- The seventh category, credits, refers to the deductions in the contract amount due to elimination of work or savings realized through existing resources and value engineering.
- Finally, the eighth category, combination, refers to the reasons for change in which a combination of any of the seven categories mentioned above are relevant.

The causes of construction project change are usually generated from either design or construction activities. The design generated causes include design changes, design errors, omissions and operational improvements. Construction driven causes are often linked to the unsatisfactory site conditions that hinder good workmanship, material handling and plant operation, *Sun et al. (2004).*

Lu and Issa (2005) also believed that most frequent and most costly changes are often related to design, such as design changes and design errors. A comparative analysis of cost variability was done by *Ndihokubwayo and Haupt. (2006)* on two completed projects to record the cost of variation orders, grouped by origin agents and causes in respective projects, the findings showed that more than 72% of the variation orders originated from the owner. Their value corresponded to more than 84% of the net total sum of variation orders. (*Ndihokubwayo and Haupt.2006).* Also, *Issac and Navon (2008)* mentioned the same conclusions. They figured out that the primary causes of change orders are owner-initiated changes and designer's errors and omissions. This conclusion confirmed later by Jawad et al.(2009) on the causes of the change.

They concluded the top five causes of variations among all contractors and consultants are as follows:

- Change of Plans by owner,
- Substitution of materials and procedures
- Errors and omissions in design
- Owner's financial problems
- Change in design by consultant.

It can be noticed that the change between *Jawad et al.(2009)*'s results and *Al-Dubaisi (2000) ones'.* In his explanation about that jawad mentioned three possible explanations to this; first, the owner was not involved in the design development. This is unlikely considering the positive or active participation of owner indicated in the first conclusion. Second, the owner did not understand or visualize the design. The designer may not have made the design clear or the owner just lack the ability to read the drawings. Third, it is merely a change of mind, while not appreciating the negative impacts of variations. The results showed that variations can be made by owner due to financial problems facing the owner, (*Jawad et al.2009).*

Ndihokubwayo and haupt (2009) concluded that the clients, with an involved of 49% and consultants with an involved of 47% were the most frequently involved origin-agents in the generation of variation orders as shown in Table(2.2),

Table 2.2 : The most frequently involved origin agents.

Origin agent	Reasons	Percentage	Clarifications
Client	Change of mind	18%	Clients change their minds or requirements
	Unclear brief	14%	Clients do not clearly state what they need then request for changes during the construction stage. Client clip is inevitable in the current market conditions

Table Cont'd

Origin agent	Reasons	Percentage	Clarifications
Client	Client satisfaction	10%	Clients pursue to achieve their dream as they wish. Since the projects ultimately belongs to them, even when they do not know what they wants, they are always right
	Budget constraints	7%	Budget constraints or the clients seek to make some savings
	Total	**49%**	
Consultant	Completeness of contract documents	18%	Variation orders originate from a consultant due to design changes or lack of detailed drawings
	Role/responsibilities into the contract	10%	Since the consultants act as an intermediate between the client and the contractor, they may initiate changes to suite the requirements of one of the parties
	Corrections	7%	A consultant usually issues instructions to correct a poor design
	Lack of understanding	4%	The lack of understanding of the requirements of the client by the consultant leads to variation orders
	Communication	4%	Lack of communication and coordination between the consultant team may lead to variation orders
	Unforeseen	4%	A consultant initiates a variation order due to unforeseen details at tender phase
	Total	**47%**	
Contractor	Forecast	**4%**	The contractor may be aware of the potential change and requests for instruction.
Contractor	Procurement approach	55%	Contractor hardly contributes to variation orders as they carries out works according to the design and has number influence on design changes
	Construction methods	9%	Request by the contractor for alternative material/method for construction
	Remedial works	9%	Variation orders issued for corrective or remedial works following a faulty of the contractor
	Total	**73%**	
Others	Unforeseen	**18%**	Unforeseen problems such as for example revision for completion date due to excessive adverse weather conditions and strikes
Client	Responsibility	**9%**	Clients are not designers

From table (2.2) we figured that; Requirement changes (18%) by the client, lack of detailed drawings (18%) by the designer, provision of an unclear brief (14%) by the client and the consultant's role/responsibility as intermediate agent between the parties to the contract (10%) are the most significant causes.

Ndihokubwayo and Haupt. (2009) elaborated more about the least involvement of the variation orders, While contractors (73%) and unspecified others (18%) were the origin agents that were least involved in generating variation orders. The dominant reasons reported were that the contractor had number influence on the design (55%) and unforeseen circumstances (18%) such as, for example, extreme weather conditions.

Chen and Hsu (2007) reported that there is 17 change-order related factors that trigger off severe disputes leading to litigation: additions, deletions, design changes, design errors, design coordination, changes in code, technique changes, manpower, material/equipment, over- inspection, reworking, scheduling, cleanup, value engineering, unknown conditions, weather, and other special reasons. He also presented that in addition to 17 changed-order related factors, there are 6 project data factors; owner type, project type, plaintiff-defendant role, contract type, project size and percentage of change.

According to *Al-jishiet and Marzoug (2008)*, the possible causes of change orders in construction of large buildings are:

1. Change of plans by owner.
2. Owner financial difficulties.
3. Owner change of schedule.
4. ill –defined project objective
5. Substitution of material or procedures.
6. Conflict between contract and document.
7. Change in design.
8. The scope of work for the contractor is Ill-defined.
9. Error and omissions in design.
10. Lack of coordination.
11. Value engineering.
12. Technology change

13. Differing site conditions.
14. Contractor desire to improve his financial conditions.
15. Contractor financial difficulties.
16. Unavailability of skills.
17. Unavailability of equipment.
18. Defective workmanship.
19. Safety consideration.
20. Weather condition.
21. New government regulations.

Burati, et al. (2009), reported the deviations or changes in constructions are caused by design, construction, fabrication, transportation or operability. Design changes, which were found to constitute 52.5% of total changes, fall mainly into three categories; design changes caused by improvement through design process (e.g changes resulting from design reviews), design changes originated by Owner (e.g scope changes), design changes initiated by Engineer or Consultant familiar with the process (e.g additions of pumps, valve or instrumentation).

Summarizing the main causes for the change order

The causes of construction project change are usually generated from either design or construction activities. The design generated causes include design changes, design errors, omissions, Design coordination and correction to design. Construction driven causes are often linked to the unsatisfactory site conditions, Value engineering, field requirement, statutory changes, work quality, discrepancies between contract documents, substitution of materials and procedures, addition work, the scope of work for the contractor is lll-defined, lack of coordination, unavailability of skills, unavailability of equipment, Safety consideration.

In addition to 17 changed-order related factors, there are four other factors related to the client; work conditions or scope changes, owner's financial problems, change of plans by owner, owner change of schedule.

2.7 Impact of Changes

In most cases, change orders are responsible for a series of impacts as they disrupt the work and affect its orderly sequence, adversely impacting productivity and accordingly causing schedule delays and cost overruns, *Moselhi et al. 1991*, *Ehrenreich and Hansen (1994) and Coffman (1997)*.The word Impact originated with the Latin word "impengere", meaning to push or hit. While some changes may bring benefits to a project, most changes, if not managed properly, can result in cost and time overruns, Sun et al. (2004).

Simpson (1998) reported that the change orders occur in almost all projects causing delays, disruptions, and resulting-in disputes. If the resulting disputes cannot be resolved by mutual agreement, it will become a claim. Unresolved claims are adjudicated by arbitration, litigation or other dispute resolution methods, as set forth in the contract. *Simpson (1998)* stated that dispute resolution is a cost of doing business and reported the estimate of its monetary value to be (3.5 - 5.0) % of the project cost.

To make a variation and process it takes time. This usually results in placing a hold and waiting for new instructions to come. In addition, equipment, tools and materials may not be the same after a variation is introduces. To procure or rent new material, tools and equipment will cause delay and cost of resources may be substantial. Furthermore, if delays are prolonged demobilization or remobilization may become quite costly, Ibbs et al.(2003).

Al-Dubaisi (2000) through his research concluded that over 50% of both contractors and consultants said the percent increase due to change orders is 6 -10% of the total project cost. Twenty six percent (26%) reported a cost overrun between 11 –15%.

The cost impacts of changes vary widely from one project to another. Although there have been cases where change cost accounted for as high as 100% of the budgeted funds, the industry norm of this percentage is about 10%, Al-Dubaisi (2000). *Sun et al. (2004),* reported that The major cost due to change is by the cost of rework or revision of work. Rework is the unnecessary effect of re-doing a process or activity that was incorrectly implemented in the first place

and can be created by defects or variations. The cost of rework in construction projects can be as high as 10-15% of contract value. While other various studies have revealed that variation orders contribute to cost overruns. A study of the effects of variation orders on institutional building projects revealed that variation orders contributed substantially to increases in construction project costs, *Arian et al.(2005).*

Recent study done by Jawad et al. (2009) concluded that Cost overruns due to variation orders were in the magnitude of 5-10% of the original contract value. This percentage is little pit raised by *Burati et al. (2009)* in their study ,a quantitative analysis of changes and their associated cost. The results showed that deviation (change) cost amounted to an average of 12.4% of the total cost of the project.

Most construction industry stakeholders are arguably interested in the reduction of overall production costs, they are not always aware of the extent of non-value adding activities on construction projects, *Saukkoriipi (2005*). In common practice, non-value-adding costs arising from variation orders that are typically transferred to the client and it's underestimated.

The cost impact of a change is greatly affected by the timing of the change, CII publications *(1994)*. A change issued before construction has limited effects as compared to a change issued after construction has already started and materials have been procured. Changes after construction or completion of design must provide high cost saving to be justified. Some owners request that a change must provide savings 10 times the direct cost required to implement them. "However if the idea that the cost of change can vary exponentially with time of introduction is accepted, that ratio should probably be 25:1 or higher in the later stage of detail design", *CII publications (1994)*. It is clear that the relation between changes and time is an exponential function. *Bruggink (1997) and Coffman (1997)* confirmed that by concluding that the highest impact of change orders occur in the third quarter of the project duration.

Beside the impact on Cost, critical change may cause consecutive delays in the project schedule, re-estimation of work statement, and extra demands of equipment, materials, labor, and overtime, *Hao et al. (2008). Al-Dubaisi (2000)*

through his research concluded that over 55% of the contractors and consultants said the percent increase is less than 10% of the original schedule. 35% said the schedule overrun is between 10 and 20% of the original schedule. Less than one percent said the increase is more than 20%.

Recent Study done by Jawad et al. (2009) concluded that Schedule overrun was reported <10% of the original contract duration.

In spite of the impact over Cost and schedule, *Assem (2000)* stated that In addition to disruption and delay, the ripple effect of change orders is considered to have a significant cumulative influence on the performance of the work as unplanned fluctuation in manpower levels resulting in layoffs, rehiring and retraining of workers. This adversely affects productivity.

Change orders have long been identified to have a negative impact on construction productivity, leading to a decline in labor efficiency and, in some cases, sizeable loss of man-hours, *Barrie and Paulson (1996) and Moselhi (1998)*. *Thomas et al. (2002)* proved that the numerical results showed about 10% decrease in efficiency for each additional 10 hours, beyond 40 hours per week, added to the schedule, based on a summary of efficiencies collected from different studies for 50, 60, and 70 hours of work per week. *Assem (2000) and Hanna et al. (2002)* concluded that the change order is one of the main factors for causing productivity loss and found that as the number of variation orders increases the more significant productivity losses become.

Later on Ndihokubwayo and haupt (2006) confirmed that the occurrence of variation orders has an adverse impact on project performance. *Thomas et al. (2002)* believed that variability generally impedes project performance. *Hanna et al.(2002)* indicated that projects impacted by variation orders cause the contractor to achieve lower productivity level than planned. *Koushki et al. (2005)* in their research found that variation orders issued during various phases of construction projects can be a major source of project claims, *Finsen (2005)* found that a large proportion of current arbitrations were on claims for additional time and additional expenses. *Ssegawa et al.(2002*) reported that more than one-third of disputes pertained to how to determine losses that stem from variation orders.

In listing the impact and effect of the change / Variation Orders*, Assem (2000)* concluded that change orders are responsible for a number of impacts, including:

1) Change of project scope, rendering the original plan incomplete,
2) Loss of labor productivity due to: disruption (hence, loss of learning curve and demotivation), congestion of trades (hence. interference, crowd, lack of availability of tools and material),
3) Difficulty of determining the equitable adjustment for the contractor,
4) Increase of administrative costs, and
5) Increase of management costs resulting from negotiations and re-planning.

While Al-Dubaisi (2000) through his research concluded the following From both Contractor's and consultants' point of views, the top five effects (prevalence) of change orders on their large building projects listed in descending order are :

1. Increase in project cost.
2. Delay in completion schedule.
3. Additional revenue for contractors.
4. Demolition and re-work.
5. Increase in contractor's overheads.

Later on Ndihokubwayo and haupt (2006) mentioned that impact of variation orders on project performance affect the following areas: *cost overruns, time overruns, quality degradation, health and safety issues and professional relations;*

1. *Cost overruns ;*The study of the effects of variation orders on institutional building projects revealed that variation orders contributed to increase in construction project cost, *Arain et al. (2005). Mohamed (2001*) analyzed the variation orders for twelve combined sewer overflow projects and revealed the cost escalation of 7% of the original projects cost.

   However, all variation orders do not increase cost of construction*. Ssegawa (2002)* indicated that omissions in most cases reduce costs while additions increase costs. In fact, the occurrence of variation orders has direct and indirect cost implications. Direct costs constitute the additional costs incurred

to perform the activities of the current variation orders. The direct costs associated with variation orders include the following:

- Resources used including labor, material and plant to carry out the actual variation order;
- Increase in overheads-related charges and professional fees;
- Cost of resources that were used to carry out the aborted or substituted works;
- Cost of demolition of aborted or substituted works;
- Cost for resources lying idle before the ordered task restarts. Resources include charges for plant hire and paid time for labor loitering around while waiting for instruction. *Ndihokubwayo and haupt et al.(2006)*

While the direct costs associated with a variation order would be easily calculated, *Bower (2000)* argued that indirect costs of a variation order are difficult to quantify. Indirect costs are those incurred as a result of the occurrence of a variation order, whether they are apparently linked to it or not. These include:

- Rework and making good on affected trades other than the actual variation order. It was revealed that the cost of rework caused by variation orders accounted for more than four-fifth of the total costs of rework, *Love and Li (2000).*
- Change in cash flow due to effect on inflation and financial charges;
- Loss of productivity due to interruption of works where the gang has to familiarize with new working conditions, tools and materials;
- Cost for redesign and administration of the variation order.
- Litigation-related costs in case disputes arise due to variation order.

2. *Time overruns*; *Hanna et al (2002)* revealed that the more the variation order occurrence the more significant productivity losses. The productivity is the amount of output over a unit of time. Therefore, the loss productivity implies loss of time and subsequent delays.
3. *Quality degradation; if variation orders are frequent they may affect the quality of works. Quality may be compromised because contractors tend to*

compensate for the losses incurred to variation orders, Ndihokubwayo and Haupt (2006).

4. *Health and Safety; the occurrence of variation orders can affect health and safety condition. This is because change in construction methods, materials and equipment may require additional health and safety measures, Arain et al. (2005).*
5. *Professional relations: A construction project creates professional relationships between parties to the contract. Each project successfully completed constitutes an added experience to participants and their reputation builds up. Misunderstanding may arise when the contractor is not satisfied with the judgment of the consultant in terms of a fair valuation of a variation order. Since the contractors are pessimist of the outcome of the negotiations, they usually allow higher value than the really cost incurred Ndihokubwayo and haupt (2006). Bower (2000) opined that this causes the contention between parties, as a consequence, this can be very damaging to relationship between all parties' representatives (Bower 2000). Charoenngam et al. (2003) remarked that disputes between the client and the contractor can occur if the variation order undertaking is not managed carefully.*

According to *Al-jishi et al. (2008)*, The impact of a change are classified as follows ;

(1) *Direct cost impact* ; The direct cost impacts are those limited to the work package in which a change is introduced ; which can be summarized as follows:

- Labor cost to demolish existing facility,
- Equipment cost to demolish existing facility,
- Materials wasted by removal of existing work,
- Associated cost of engineering /shipping and handling of waste materials.

(2) Direct schedule impact

(3) *Indirect or Consequential Impacts*;

The following are among the possible consequential effects;

- Effects on the methods or procedures used in other work packages due to a change in a previous task or package
- Degradation of productivity in subsequent packages or activity

- Increase in overhead cost
- Impact on subcontractors
- Miscellaneous.

According to *Al-jishi et al. (2008)*,the Effects of change orders that are usually encountered are:

1. Decrease in productivity.
2. Delay completion schedule.
3. Dispute between owner and contractor.
4. Decrease in quality.
5. Increase in project cost.
6. Additional money for contractor.
7. Delay of material and tools.
8. Work on hold.
9. Increase in overhead expenses.
10. Delay in payment.
11. Demolition and rework.

Jawad et al. (2009), Based on a previous study among 17 contractors and 17 consultant on the causes of the change. The overall ranking of the top five most prevalent effects of variations among all contractors and consultants is as follows:

- Increase in project cost
- Delay in completion schedule
- Additional revenue for contractor
- Demolition and re-work
- Increase in contractor's overhead

A Field study made by *Ndihokubwayo and haupt. (2009)* over 30 companies obtaining an equal representation in a stratified sample of contracting, cost consultant and architectural companies shows that ; Almost two-thirds of respondents (60.9%) reported that clients were fully aware that unnecessary costs accrued on variation orders. The top ten of the most prevalent impact of variations is shown on table 2.3 ;

Table 2.3 : Most prevalent impact of variations

Impact	Rank
Cost overrun	1
Time overrun	2
Disputes between parties to the contract	3
Additional specialist equipment/personnel	4
Complaints of one or more of the parties to the contract	5
Quality standards enhanced	6
Professional reputation of one or more parties adversely affected	7
Additional health and safety equipment/measure	8
Degradation of quality standards	9
Optimum cost reduction	10

2.8 Control / Manage Change Process

Change management in construction requires an integrated solution to discipline and coordinate the process, for example, documentation, drawing, process, flow, information, cost, schedule and personnel. The construction industry needs an effective construction change management process (Osman et al. 2009). Most changes, if not managed properly through a formalize change management process will result in "negative" impacts stated early at this chapter and sometimes may lead to contract disputes, which is a severe risk contributing to project failure in general *(Hao et al. 2008).*

Unlike project management, which attempts to minimize the occurrence of change orders, change management is a new rising branch that aims to absorb change orders and reduces their impacts (*CII Puplication 1994).*

Project changes and/or adjustments are inevitable as they are a fact-of-life at all stages of a project's life cycle. Managing changes effectively is crucial to the success of a construction project, (*Hao et al.2008).* The effort of managing change orders has imposed a huge burden on project management (*Hao et al. 2008)*. The need of an effective construction change management versus the scarcity of meaningful research and development (R&D) work appears to be a fact in the construction industry. In practice there are number widely accepted standard and comprehensive change management methods (*Sun et al. 2004).*

There is very limited research works addressing the change management issues specifically within the construction project management context summarized *as follows* ;

- *Sun et al. (2006)* designed a change management toolkit for construction projects which works on the basis of interrelation ship, in fact interdependency characteristics, causes of change and impact of change. Its main purpose is to predict change events at the early stages of the projects and therefore enable appropriate actions to minimize their disruptive effects.
- *Motawa et al. (2007)* presented some preliminary results on proactive change management through an integrated change management system composed of a fuzzy logic-based change prediction model and a system dynamics model based on the Dynamic Planning and control Methodology (DPM) which has been developed to evaluate the –ve impacts of changes on construction performance. The developed system can be used in managing change scenarios on projects and also in evaluating change effects depending on the available information at early stages of the projects.
- *Charoenngam et al (2003)* discussed Web-based project management and a Change Order Management System (COMS) specifically developed for coping with changes in construction projects. Standard web technologies were used and a change order procedure involving workflows, roles/actors, documents, records keeping, and a centralized database were developed.
- *Recently, Issac and Novan (2008)* have proposed a change control tool (CCT) which creates requirement traceability through links between client requirements and the building design. They believe that number of changes or the impact of changes can be controlled by capturing client requirements accurately at the beginning of the of the project and through the requirement traceability that is build up afterwards.
  Apart from the project management domain, some other researchers have been trying to address change management issues in various other ways (Hao et al. 2008).

- 4D or 5D integration which integrates time and cost models in addition to 3D geometry models. In this way, changes can not only be controlled in the design and engineering stages in the whole construction process, but also be controlled in the built environment lift-cycle to some extent.
- Data sharing and interoperation. *Bakis et al. (2007)* proposed an approach to model the complex interrelations of the different components of the various aspects of the design and the different versions of each component in order to maintain consistency in architectural design. When changes happen, the interrelation models help notification / propagation of version changes.

According to *CII publication (1994)*, Changes are looked at as a major source of construction claims and disputes. The major legal aspects are:

(1) Selecting the best delivery system (contract format)

(2) Drafting and interpreting change clauses

(3) Documenting change orders to be ready in case of litigation

As ascertained *Al-Dubaisi (2000)*, "An owner's management of change orders and claims must also anticipate and provide for dispute prevention and dispute resolution processes from the outset".

However, there are few points that affect how a project will cope with changes and problems anticipated according to *Al-Dubaisi (2000)*, change orders is subjected of the contract format used. Owners should consider changes when considering the type of contract for their project in terms of the ability of the contract to contain and minimize changes (*CII publication1994)*.

Al-Dubaisi (2000) reported that there are numerous contract types used in construction depending on owner and project requirement. The more common types are ;

1. Fixed Price Contracts :
   a) Lump Sum,
   b) Unit Price,
   c) Guaranteed Maximum.
2. Cost-Reimbursable Contracts :
   a) Cost Plus Fixed Fee,

b) Cost Plus Percentage,

c) Target Price Plus a Fee.

Certainly not all types of contracts are equally sensitive to changes. If contracts are classified as either cost reimbursable or fixed cost, the latter will be the most sensitive to changes.

Al-Dubaisi (2000) suggested that the winners of bid awards are not only willing to assume the risk of losing profits, but are also willing to improve their financial position through excessive use of change orders.

A Field study made by *Ndihokubwayo and Haupt (2009)* showed that ; 91.3% agreed that a clause permitting variation orders was an essential feature of any construction contract,

Both owners and contractors hope to avoid the litigation solution thus if a system is design provides early warning this would be useful (*Chen and Hsu 2007).*

The most important clause in this regard is the change clause: “Change clauses are an important element of the contract because they provide mechanism for contract modification (either to react to unexpected events or because the owner desires change) and for appropriate compensation” (*CII publication 1994).* The change clause establishes the right of the owner to make changes within certain limitations and through a defined mechanism (*Al-Dubaisi 2000)*. While in sometimes an owner or an engineer may attempt to avoid responsibility of changes by using a disclaimer clause or risk-shifting clause in the contract (*CII publication 1994).* Such a clause may state that ‘subsurface data provided is for information only’ and the owner is not responsible for any variation.

The owner or the engineer may also place a design responsibility on a contractor, whereas it is the responsibility of the engineer under common law or traditional industry practice. By using such clauses an owner or an engineer is transferring the risk to the contractor. These clauses, if used, become risk items in themselves which affect the contractor bidding strategy, which requires contractors to allow for these shifted risks in their bids and go into their project with open eyes.

It is important to have a well-developed program for the management of

changes. This includes a change control program and change order administration during initiation, evaluation, approval and implementation stages.

The concept of early warning is already widely applied in the fields of finance, quality control, information management, biomedicine and engineering. According to *Chen and Hsu (2007)*, an early warning system (EWS) can serve as reference to examine whether a bank win suffer bankruptcy or not .

The Changes Impact Task Force of the *Construction Industry Institute (CII)* prepared a checklist of the most common parameters to consider when considering a change. These parameters were classified under different categories.

According to *Thomas et al. (1994*), the major categories are:

- Size and scope
- Nature of the scope
- Timing
- Managing Impact
- Who does the change
- Site conditions (environment)

In its special publication *(1994), the CII Project Change Management Research Team* recognized five principles for effective change management:

- "*Promoting a balanced change culture*" allowing 'beneficial' changes to proceed while discouraging or preventing changes that do not meet this criterion, or changes the team termed 'detrimental'. Detrimental changes are defined as "those that reduce owner value or have a negative impact on a project".
- "*Recognize Change*". According to the CII team, there is a common disagreement between parties on what constitutes a change The team suggested many ways to enhance change recognition including, flowcharting change management process, devoting specific meetings for change identification
- "*Evaluate Change*". This principle requires a change to be classified as required or elective. Required changes are required to meet original

objectives of the project while elective changes are additional features that enhance the project.

- "*Implement Change*". This principle requires the flexibility of team members to implement changes at any point on the schedule. Established procedures must be set for authorization and documentation.
- "*Continuously improve from the lessons learned*". The team emphasized
  the need to learn from the lessons of past projects executed by an organization.

Motawa (2005) proposed two approaches for managing change - reactive and proactive. In the *reactive approach*, the objective is to improve efficiency in handling changes after they have already occurred whereas in the *proactive approach*, the aim is to identify and forecast potential changes and develop solutions before the change occurs. *Later Motawa et.al (2007)* presented an integrated change management system which covers the life cycle of changes within construction projects. The system consisted of two components; a Dynamic Planning and Control Methodology (DPM) and a change prediction system. DPM has been developed to overcome the uncertainties and complexities resulting from changes in concurrent design and construction by focusing on iterative cycles caused by changes and their impacts on construction performance. While the change prediction system aimed to determine the likelihood of change occurrence, which is a measure of the project stability.

Motawa (2005) reported that, studying the relationships for the stages of the of the project changes helps in predicting the potential changes in case they have not occurred yet for the purpose of minimizing their disruptive effects. To reduce the disruptive effects of change, it is important to identify what project characteristics lead to change causes and what these causes are
The main categories of the project characteristics, at the highest level are:

(1) *Economic Issues.* The construction industry is significantly affected by macro-economic conditions.

(2) *Demographic issues.* International, national and regional demographic shifts can impact on construction works.

(3) *Technological issues.* New technologies, taken up by the construction industry, arise due to a push and pull and are being developed continuously. Therefore careful evaluation of adoptive technologies must occur to ensure they will enhance the lifecycle and add value to the facility over its lifespan.

(4) *Customer / stakeholder issues.* Identifying potential stakeholders to the project reduces risk and cost.

(5) *Legislative issues.* The governing power in a State will exercise an authoritative direction or regulation, which may cause change to occur.

(6) *Competitor issues.* This task ensures that the client has an appropriate level of market intelligence with which the business strategy may be affected.

(7) *Environmental issues.* Many organizations lobby government to amend and create new policies and legislation associated with construction project regarding the environment

The “project characteristics” mentioned above have dealt with the information related to change at the early stages of projects. However, the direct causes of change can only be recognized when the actual implementation of the project shows the need for change, *Motawa (2005).*

An effective construction change management system will have the following requirements: Hao et al.(2008)

a) Consolidating all aspects of change information, including causes, symptoms, sources, impacts, actions, and processes of changes and their linkages
b) Evaluating all elements affected by a change, across all design and construction phases

c) Automating workflow processes for change review, approval and implementation
d) Coordinating changes into operational systems of different parties
e) Coordinating changes into a shared project management system
f) Coordinating people's activities (including notification, reminding, monitoring, etc.)
g) Coordinating the distribution and management of documents and drawings in latest versions
h) Day-to-day process and cost recording
i) Dispute resolution procedure
j) Change traceability and post-change analysis

PMBOK Guide (2009) provided basic principles for scope change control. This control is concerned with:

1. Influencing the factors which create scope changes to ensure that changes are beneficial,
2. Determining that a scope change has occurred, and
3. Managing the actual changes when and if they occur.

Jawad et al. (2009), concluded in their study among 17 contractors and 17 consultants on the causes of the change, the top five most utilized controls by contractors and consultants to safeguard against occurrence of variation orders to minimize their impacts:

- Clarity of scope of variation
- Appropriate approval in writing
- Negotiation by knowledgeable people
- Checking and review of design variations for feasibility
- Team effort between parties.

Ibbs et al. (2001) introduced a change management system that is founded on five principles:

1) promote a balanced change culture;
2) recognize change;
3) evaluate change;
4) implement change;

5) continuously improve from lessons learned;

Each of these principles works hand-in-hand with the other to minimize deleterious change and promote beneficial change.

Based on case studies and a review of existing research done by Sun et al. (2004), a generic change management process model is defined (Fig.2.2). The generic model consists of four stages, Start Up, Identify & Evaluation, Approval, and Implement & Review .

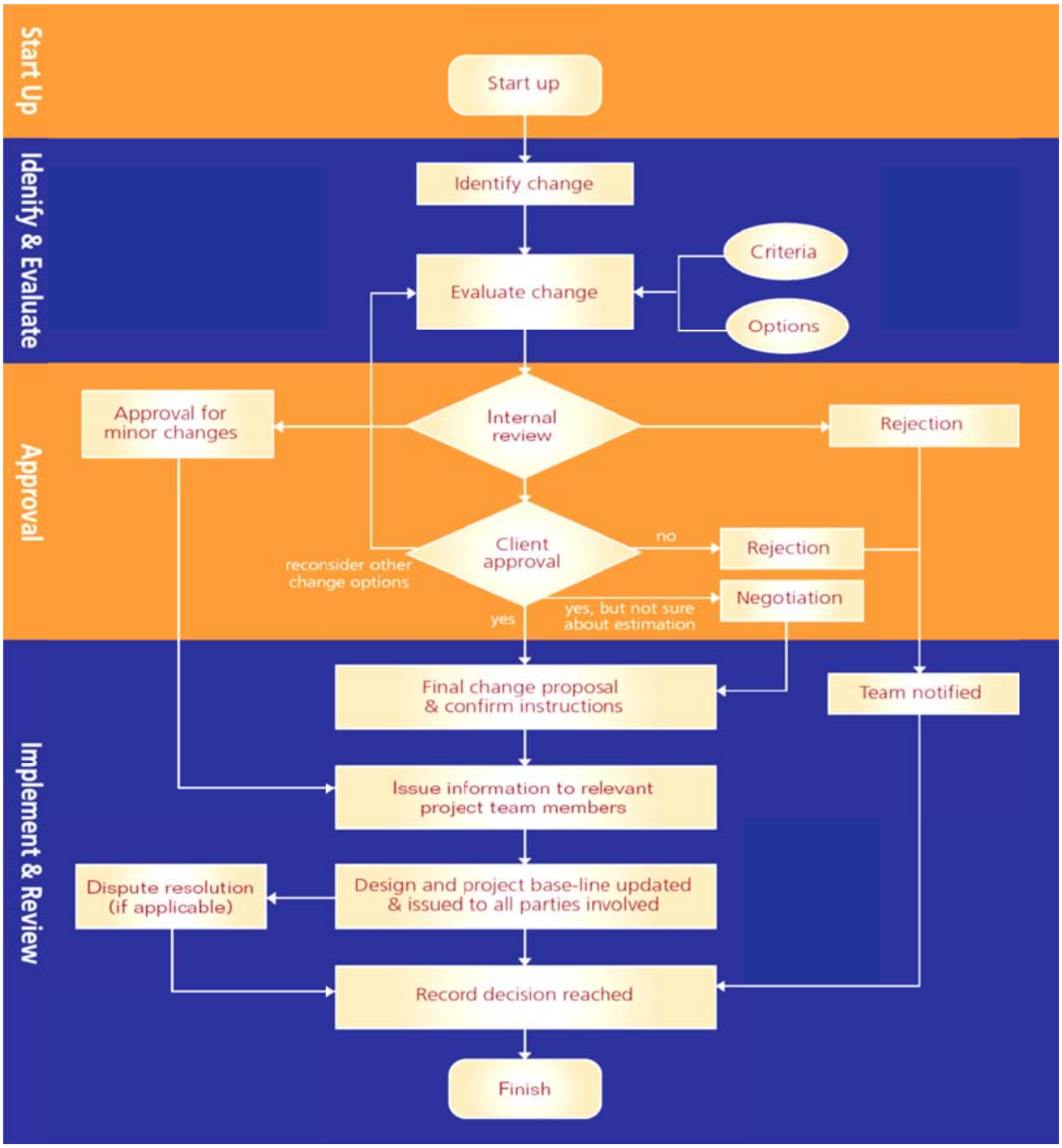


Fig.2.2

Generic change management process model (Sun et al. 2004)

Changes with noticeable impacts, either reworks or change orders, all requires a following formal process in change management. A generic

change process model is considered to have five stages in a sequence: identify, evaluate & propose, approve, implement and review (Fig.2.3) Hao et al. (2008)

1. Identify changes. This requires an effective change management system to build up the relationships of the requirements, symptoms, malfunctions, and various other aspects of changes.
2. Evaluate and propose changes. Based on criteria and options, the evaluation module calculates all possible impacts that an identified change can have on other processes and team members, in terms of time and cost.
3. Approve changes. Each identified change needs to go through a formal approval process.
4. Implement changes. The change management process model requires all the parties involved to keep records of all relevant information on change cases to build a case base for future use. Unlike previous stages, number major decision is expected during the change implementation stage.
5. Analyze changes. Change analysis and system performance is reviewed based on the data collected during the change implementation phase.

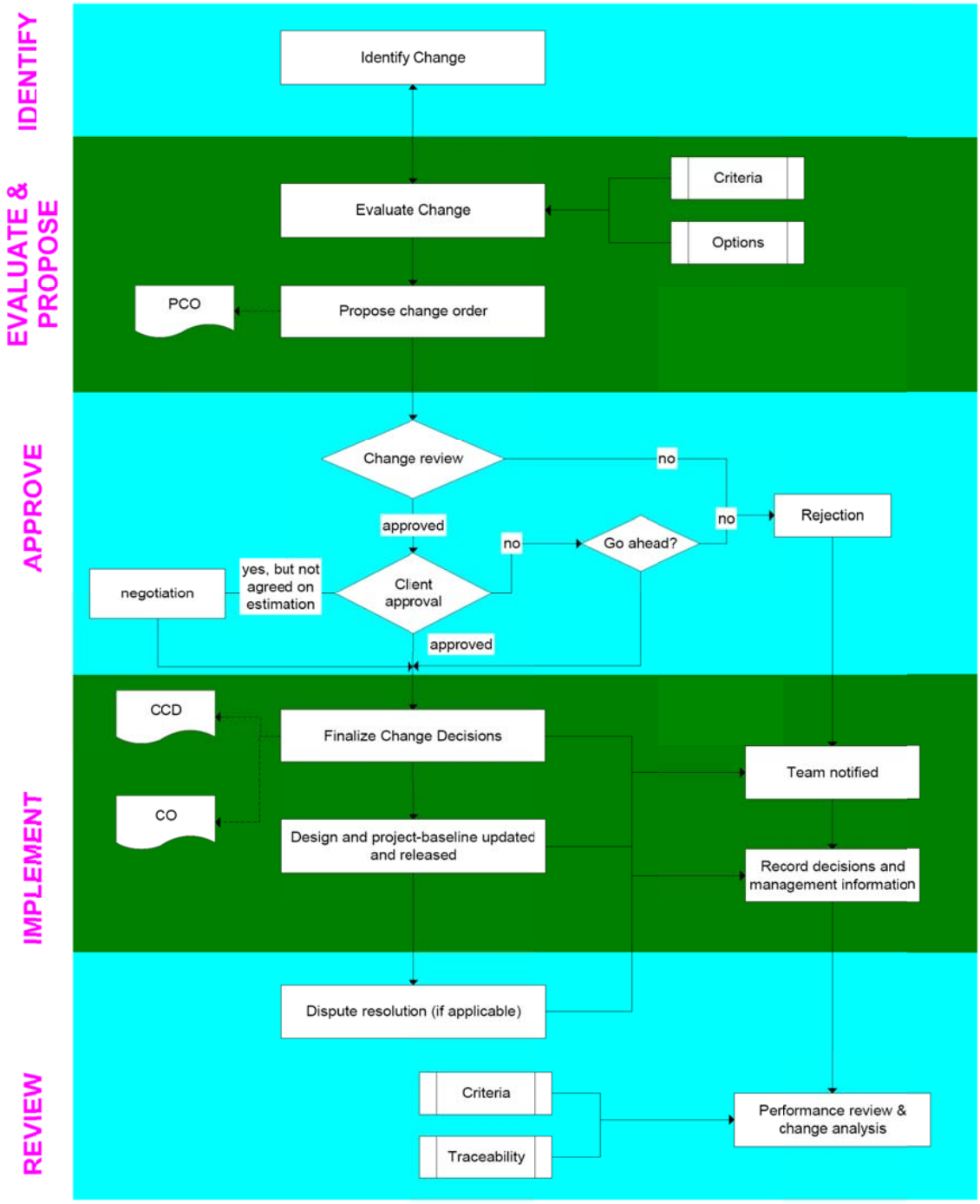


Fig.2.3 Generic change management process model (Hao et al. 2008)

Motawa (2005) and *Motawa et al.(2007)* has developed a change process model for construction (Generic Process Model) based on four main parts (Pre Change, Identify & evaluate Change, Approval & propagation & Post Change) for predicting the likelihood and impact of change ;

(1) Pre Change: the generic process defines a set of proactive requirements that are essential for effective change management.

The main proactive requirements ;

- Allocate resources for change management function
- Initiate and select change management process for project
- Approaches towards change management
- Align project elements to change management process

The main functions that these requirements should provide, are:

- Project baseline and detailed cost and time plan,
- Knowledge base that includes criteria for deciding on change and evaluation in terms of the key project objectives,
- Integrated system for design management,
- 3-D modelling that assists fast and more detailed assessment of the impact of proposed construction changes.
- Procurement routes should consider change

(2) Identify & evaluate Change ; the approach adopted in this research classifies change identification into these main categories:

- Monitor deviations from project programme,
- Analyze and consider implications of identified deviations,
- Develop mitigation strategy for change event,
- Update change management repository.

Types of change may be minor/major, required/elective, or pre-/post-fixity. Various criteria can be used to identify the change type such as:

- The need to rework;
- The volume of rework due to change in terms of costing and
- duration with respect to the project cost and duration;
- Size of disruption to the workflow.

(3) Approval & propagation ; Client approval is an important step in the process.

(4) Post Change ; the disruptive effects of change can be minimized when the project team can experience their knowledge about previous cases. The model defines the following categories for this stage:

- Measure Change effectiveness
- Analyze work inactivity and ineffective work

One of the most practical control systems is the one presented by Oracle *(2009)* (Fig.2.4) which defines the five steps for the change management process as follows;

Step 1. Identify the contract requirements.

Step 2. Identify the potential change and create a potential change order file.

Step 3. Determine entitlement, measure the effect of the change, and calculate the cost of the change.

Step 4. Negotiate and execute the change order.

Step 5. Maintain complete records of the executed change.

Step1. Identify the contract requirements; The contract documents (Contract , Specifications and drawings) identify the requirements for the project in terms of its scope, schedule, and budget. The contract requirements must first be identified so that any deviation can be recognized. The owner and contractor should also pay particular attention to the contract clauses related to notice and changes (eg Changes Clause, contractor notice clause and Contract Ambiguities, Conflicts, Errors, and Omissions), because these clauses are the logical starting points for the identification and administration of changes.

Step 2. Identify the potential change and create a potential change order file; When a potential change is identified, it is important to correctly classify it and follow the correct procedures.

Step 3.Determine entitlement, measure the effect of the change, and calculate the cost of the change Upon receipt of a PCO, the owner must, in a timely fashion, evaluate the PCO and determine whether the contractor is entitled to the recovery of the additional time and costs requested.

Step 4. *Negotiate and execute the change order*.

Step 5. *Maintain complete records of the executed change*

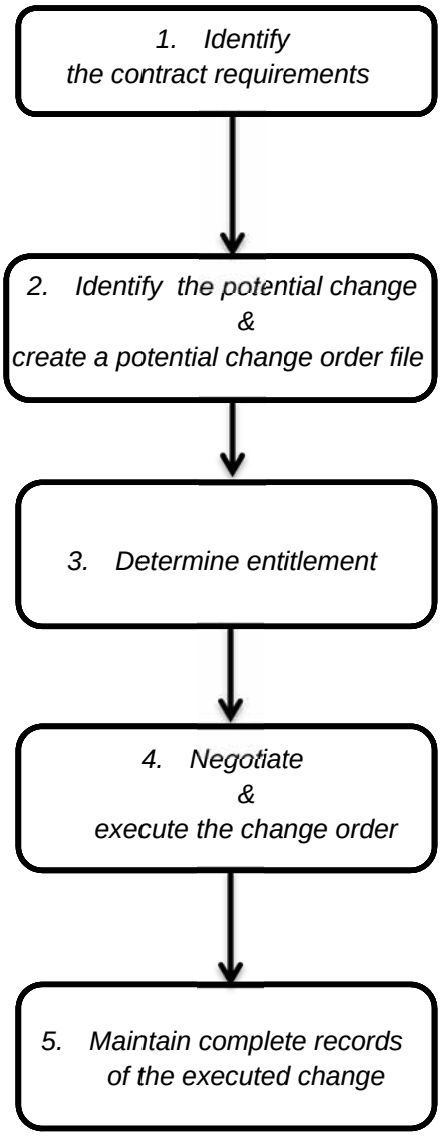


Fig.2.4 Practical control system (Oracle 2009)

According to *Sun and Oza.(2010)* traditionally, change and variations often cause disputes, claims, delays and cost overruns in construction projects. The New Engineering Contract (NEC), initially published in 1991, is designed to encourage good management practice and to improve the contract change management process, *Mitchell and Trebes (2005).* The essence of NEC is the emphasis on team collaboration when dealing with changes that might affect cost, timescale and quality of product. The key stakeholders of a project (e.g the contractor and project manager) are required to provide each other early warning usually triggers a sequence of communications between the

contractor and the project manager. NEC requires that all communications are done in writing and replies to be given within a time limit specified in the contract (*Sun and Oza 2010)*

Sun and Oza (2010) reported that the New Engineering Contract (NEC) contract seeks to address the challenge of contract change through encouraging good management process and better collaboration between all parties involved in the decision making process, it requires principal parties to notify each other as soon as certain conditions become apparent, which may lead to project changes at a later stage. This is called an Early earning (EW) because it allows the team time to consider their option to deal with the risk, before it impacts on the project's timescale, costs, safety or quality.

It might sound simple, but the procedures and documentation of a change are a very vital elements in any change management program. The process starts when the owner, the owner's representative, or the contractor initiates a change and continues until the change is ready to be implemented (*Al-Dubaisi 2000)*.

According to *Pruitt (1999),* the approval of a change order is just the beginning, which must be followed by a course of action "to insure that the change is adequately documented".

Al-Dubaisi (2000) concluded that the complexity of procedures is a problem in large organizations. Too many control systems and technical department approvals become barriers to an efficient change order procedure. The inefficiency cost could be quite enormous. In addition, the level of trust between the parties has a direct impact on the simplicity or complexity of the change order procedures. The less the trust, the more cumbersome is the procedure. In a situation of a low level of trust, contractors indicated that a contingency factor of 2.3% could be assigned. *(Al-Dubaisi 2000).*

The scope change control which is divided into: Inputs, tools & techniques and outputs, must be thoroughly integrated with the other control processes (ex. time control, cost control, quality control, and others).

- *The inputs* to the scope change control include:
  a) The work breakdown structure (WBS) which defines the project's scope baseline,
  b) Performance reports providing information on scope performance and alerting the project team to issues which may cause problems in the future,
  c) Change requests that may occur in many forms: oral or written, direct or indirect, externally or internally initiated, and legally mandated or optional,
  d) Scope management plan describing how project scope will be managed and how scope changes will be integrated.
- *The tool and techniques* for scope change management include:
  a) Scope change control system which defines the procedures by which the project scope may be changed, including the paperwork, tracking systems, and approval levels necessary for authorizing changes,
  b) Performance measurement that helps to assess the magnitude of any variations which may occur, and determine the cause of the variance, and decide if it requires corrective action, and
  c) Additional planning which may require modifications to the WBS or analysis of alternative approaches.
- *The outputs* of the scope change control include:
  a) Scope changes which is any modification to the agreed-upon project scope as defined by the approved WBS, and they often require adjustments to cost, time, quality, or other project objectives,
  b) Corrective action is anything done to bring expected future project performance into line with the project plan, and

Lessons learned which comprise any lessons learned from scope change control that should be documented to form part of the historical database for both this project and other projects of the performing organization

Summarize the effective principles for the change management system preferred :

1- Identify or recognize the change,
2- Evaluate it,
3- Approve it,
4- Implement it
5- Analyze it to improve the system continuously.

CHAPTER THREE
DATA COLLECTION

Chapter Three
Data Collection

3.1 Introduction

The data collection stage outlines the collection of the data used in this research. In impact related studies, there are two commonly used approaches to collect data: questionnaire and/or case study.

The questionnaire approach is used to collect the data, It is the medium though which responses are recorded to facilitate data analysis. The primary purpose of a questionnaire is to investigate the construction experts' point of view regarding the change order management. It serves as a standard guide for the interviewers in which each need to ask the questions in exactly the same way. Without this standard, questions would be asked in a haphazard way at the discretion of the individual.

3.2. Questionnaire design

The questionnaire design took into consideration the objectives of the study as stated in Chapter one and two with the aim to answer the research questions. Great effort and brainstorming went into designing the questionnaire. Meetings with professional were conducted to identify the right questions required and to present them in a clear and an unambiguous format. Special care also went into phrasing the questions in a language that is easily understood by respondents.

3.3 Contents of the Questionnaire and measure

The questionnaire was structured in three sections as follows;

Section A: To provides data regarding the personal information of the surveyed respondents, the organization in which the respondent serves; his /her role in the organization, working experience, organization type and organization experience. Basically there are eight questions in this section. The respondents were requested to choice a clear answer.

Section B: To obtain answers from respondents regarding the project data and their experience with regard to the project data, causes, effects and impact of change orders. it is divided into four parts,

The first part discusses the results on the general information about the project data included questions about the project type, construction type, size, owner type and contract type. These features are thought to have bearing on the change orders magnitude and consequences

The second part which is based on project data covers the change orders' general data. Such part mainly include questions about the number of the change orders initiated by each party, the compensation method for the change orders, types of changes which are authorized to proceed without formal (written) approvals, how many approvals are required for change order needed, working relation between parties, the primary driving factors for change orders and which craft generates more change orders (Electrical, mechanical, structural, civil or finishes).

The third part is based generally on respondent experience. It is related to the causes leading to changes; It asked which are the most five causes of variation orders in the projects, the level of owner involvement among the project phases, the most frequently involved origin-agents in the generation of variation orders and to rank the most causes for it.

The forth part is based on project data. It is related to the effect and the impact of change orders on the projects, it asked about the percentage of the cost increased resulting from the change orders, the percentage of delay time resulting from change orders and what are the top five prevalent impact of the variation orders.

The measure of this section based on a quantitative scale.

Section C: To obtain data from respondents on the control/management of the change orders. It was divided into two parts.

The first part is based on respondent experience. It asked about respondent's opinion of whether clause permitting variation orders was an essential feature for any contract or not and the most certain success factors for the change orders implementation.

The second part is based on project data. It asked about if a system for change management is utilized or not, through the change order generation and execution.

The measures for part one in this section basically used a well-defined answer for the respondent to choice. The second part which covered the control and management of the change orders used ordinal scale.

This ordinal scale does not offer in its qualitative 5 point scales a direct quantitative comparison between its intervals. The survey respondents were asked to rate against the five-point scale. The responses to this section of questionnaire is based on Likert's scale of five ordinal measures which is from one (1) to five (5) according to the level of contributing factors attributed to the question as shown in Fig.3.1.

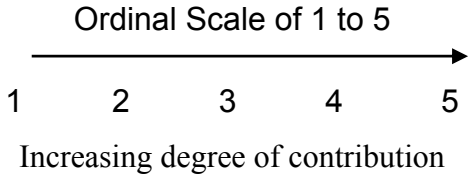


Fig.3.1 : Five Ordinal measures of agreement by Likert Scale

The Likert Scale of measurement represents the following scale:

5= Highly contributing or very often,
4= High contributing or Often,
3 = Medium contributing Or Sometimes,
2= Low contributing Or Seldom,
1= Least contributing Or Never.

Responses to this section of questionnaire were then analyzed. The analysis included ranking the factors in terms of degree of contribution. The main approach used to analyze the data is by using the 'Relative Index' (RI) technique. In the computation of the Relative Index the following formula was used

$$RI = \frac{\Sigma(5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1)}{5(n_5 + n_4 + n_3 + n_2 + n_1)}$$

Where:

RI = Relative Index

n5, n4, n3, n2, n1 = Number of responding indices

The computation of the RI using this formula will yield the value of RI ranging from 0.2 to 1. The values 0.2 represent the lowest strength and the value 1 representing the maximum strength.

Prevalence and Utilization Indices will be calculated in the same way. Causes, effects, and controls (Section B) will be ranked on the basis of their indexes with the first rank assigned to the highest index.

A sample of the questionnaire is shown in Appendix C

3.5 The Statistical Sample

3.5.1 Sample Selection

Two restrictions were imposed on the selection process of respondents:

2. Restricted to large contractors (Grade 2 or better)

3. Restricted to building projects.

With these restrictions in mind, the researcher targeted both populations i.e. all the list of contractors as presented in the Egyptian Federation for Construction & Building Contractors in Egypt classification.

The Egyptian Federation for Construction & Building Contractors in Egypt classified the contractors from first grade to six grades. This classification depends on the business volume, the contractor's annual business, experience of contractors, technical staff, financial staff, number of permanent employees, the value of equipment owned, legal & management staff…….etc. Therefore, the size of contractor depends on their largest grades of the main field in the construction industry.

According to the Egyptian Federation for Construction & Building Contractors in Egypt in 2011 the approximate number of contractors in Cairo and Alexandria without the contractors having the seventh grade is 4090 contractors, which is the whole population.

In this study, the selected contractors are limited to the 1st and 2nd grade because they can be considered the highest experience in the construction industry, executive contractors, and their works are big. The total number of contractors within the two classes at the Egyptian Federation for Construction & Building Contractors in Egypt is 92 Contractors.

The minimum sample size was calculated according to Wessa (2008), Minimum Sample Size (Testing Proportions, Version 1.0.3) in free statistics Software (V1.1.23-r7),Office of Research Development and Education.

The following results are obtained in Table 3.1;

Table 3.1 : Minimum sample size results

Minimum sample size	
Population size	92
Margin of error	0.05
Confidence	0.95
Power	0.5
Response Distribution (Proportion)	0.5
z(alpha/2) + z(beta)	1.95996398454005
Z(alpha) +z(beta)	1.64485362695147
Minimum sample size (2sided test)	34.3801482535484

The calculated sample size was found to be 35 contracting companies based on 95% confidence level and margin of error 5%.

In order to have a good representation for all the entities working in the construction industries. The Questionnaire were sent to consultants, designers and others working in the field (e.g project management firms) .

3.5.2 Gathering of Data and Rate of Response

The respondents are grouped into four groups; contractors, consultants, designers and others. The returns from the four groups are shown in Table 3.2, showing an average response rate of 81 percent. Twenty seven responds from 35 Contractors, Twenty one responds from 30 Consultants, fifteen responds from seventeen Designers and seven responds from eight Others were received. A list of respondents is presented in Appendix (A)

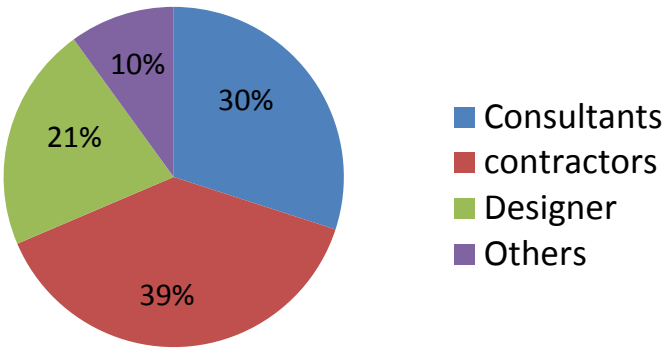


Fig.3.2 Rate of Respondents

Table 3.2 : Questionnaire Return Rate

Group	Number of questionnaire Sent	Number of responses received	Response rate (percent)	Proportion (percent)
Contractors	35	27	78	39
Consultants	30	21	70	30
Designer	17	15	88	21
Others	8	7	87.5	10
Total	90	70	80.9	100

3.5.2 Respondents' Background

Out of the twenty seven responds received from Contractors (Table 3.3), fifty six percent were project managers, fifteen percent were construction managers, four percent were site managers, same percent were quality managers, eleven percent were cost managers and same percent were schedule manager.

Table 3.3 : Contractor respondent classification

Contractor	
Project Manager	56%
Construction Manager	15%
Site Manager	4%
Quality Manager	4%
Cost Manager	11%
Scheduling Manager	11%

Out of the twenty one responds received from Consultant (Table 3.4), fifty seven percent were project managers, twenty four percent were construction managers, five percent were quality managers and fourteen percent were resident engineer.

Table 3.4 : Consultant respondent classification

Consultant	
Project Manager	57%
Construction Manager	24%
Quality Manager	5%
Resident Engineer	14%

Out of the fifteen responds received from Designer (Table 3.5), fifty three percent were project managers, thirteen percent were construction managers, twenty seven percent were quality managers and seven percent were scheduling managers.

Table 3.5 : Designer respondent classification

Designer	
Project Manager	53%
Construction Manager	13%
Quality Manager	27%
Scheduling Manager	7%

Out of the Seven responds received from Others (Table 3.6), forty three percent were project managers, twenty nine percent were cost managers and same percent were scheduling managers.

Table 3.6 : Others respondent classification

Others	
Project Manager	43%
Cost Manager	29%
Scheduling Manager	29%

CHAPTER FOUR
RESULTS & ANALYSIS

Chapter Four
Results & Analysis

4.1 Introduction

This chapter analyses the data collected from the questionnaires and interviews. The method used is discussed in Chapter three. The collected data from the questionnaires were tabulated and analyzed according to their ranking on relative index. Information provided from the selected respondents is presented. The objectives of this chapter is to identify the most significant causes of the change order and the highest impact that raised due to the change order in addition to the highest ranked parameters for the management of the change order among Egyptian projects.

4.2 Analysis of Data from Questionnaires

In this chapter the collected data are analyzed in the same order as they are presented in the questionnaire form.

Although the data obtained from the questionnaires should be presented in two different ways of analysis; the data based on the experience of the respondents and the data collected from the projects. But for the ease of work and to avoid conflicts and confusion, the data presented are the same as required by questionnaire.

4.3 Survey results

4.3.1 Section (A)

4.3.1.1 Organization Data

Survey results on organization data are presented in graphical representation

The distributions of the level of experience for contractors, consultants, designer and others are shown in following in Fig.4.1 :

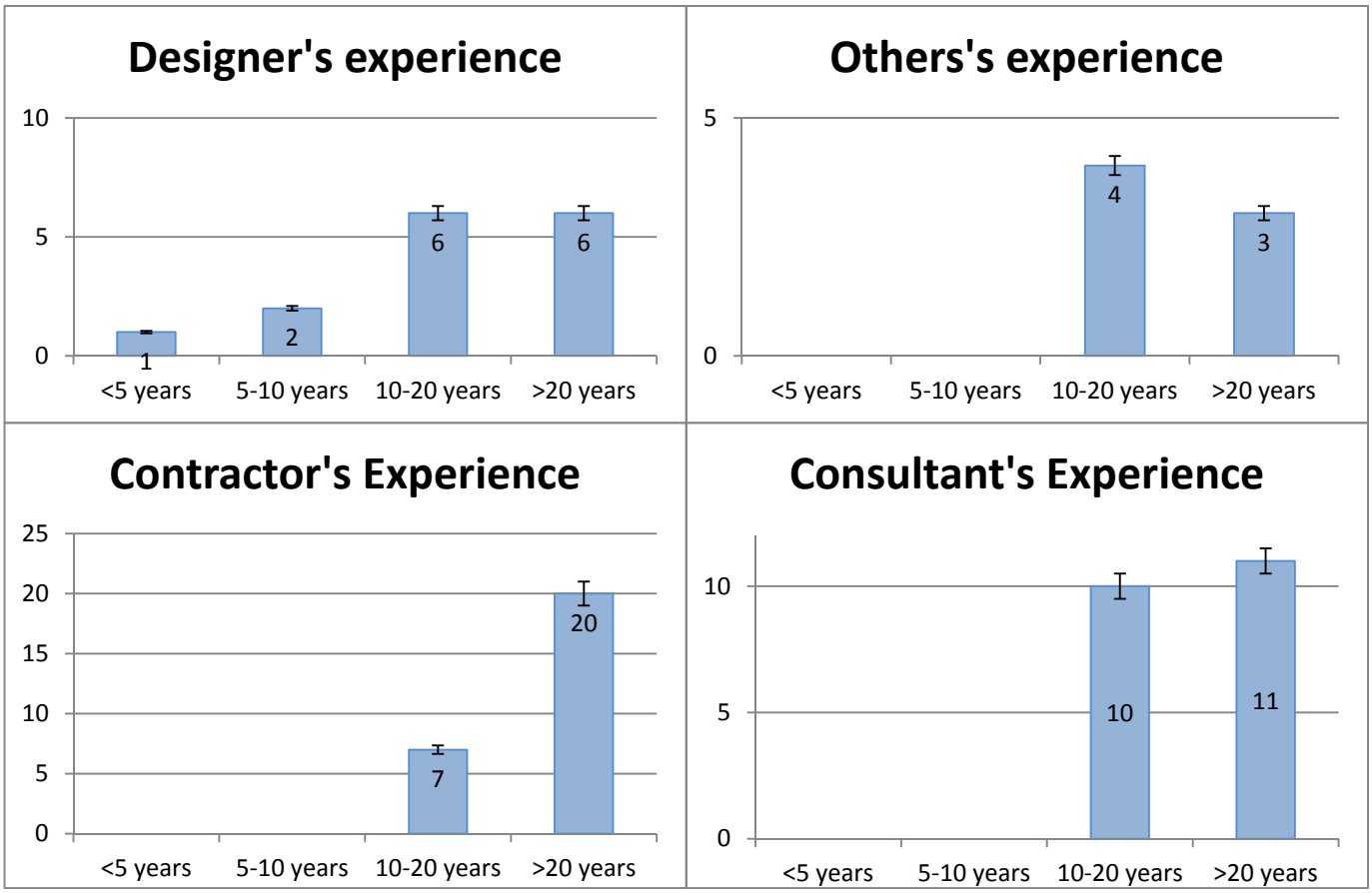


Fig. 4.1 The level of experience categorized by discipline

From the previous figure, we can notice that almost all the respondents had either experience between 10 to 20 years and more than 20 years which strength the result obtained as their responds were based on sufficient years of experience that allow them to digest the question well and return back a precisely answer.

4.3.2. Section (B)

4.3.2.1 Projects' Data

The types of projects collected are shown on Fig. 4.2 categorized as follows :

1. Commercial,
2. Residential,
3. Industrial,
4. Infrastructure,
5. Institutional,
6. Military.

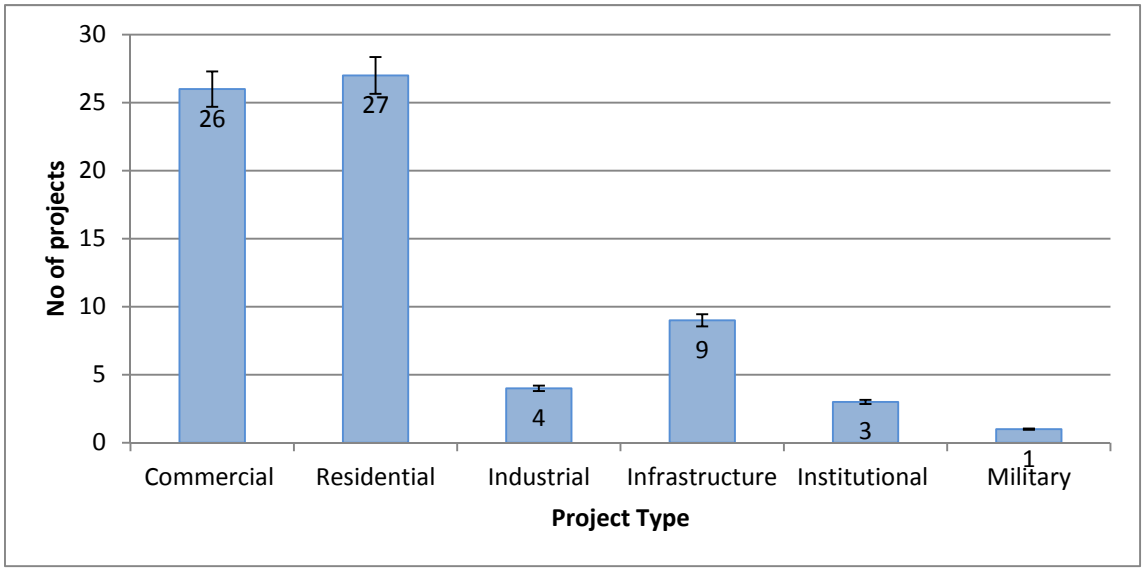


Fig. 4.2 Types of Projects

The above mentioned figure represents the number of the projects collected categorized by project type. We can notice from the figure that the number of the *commercial* and *residential* projects is the highest, 26 & 27 respectively represents around 76 percent of the project collected, which reflect the majorities of the project type in Egypt now.

The distribution of projects sizes shown in Fig. 4.3 Categorized by the Project type,

Size of project are categorized according to the project cost based on the experts interviewed during questionnaire preparation as follows:

1. Mega (more than 500 million EGP),
2. Very Large (between 250 and 500 million EGP),
3. Large (between 100 and 250 million EGP),
4. Medium (between 50 and 100 million EGP),
5. Small (Less than 50 Million).

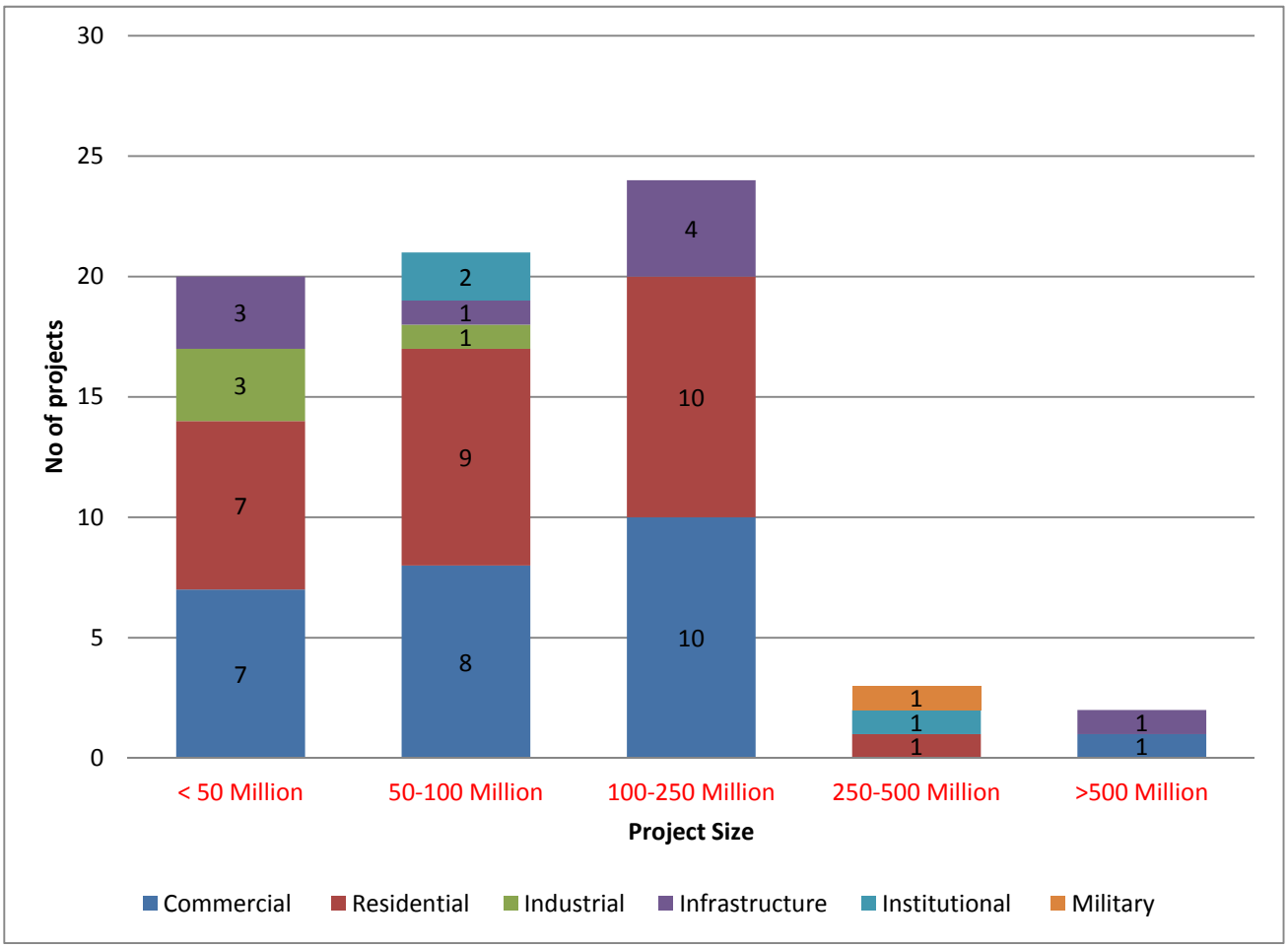


Fig. 4.3 Distribution of projects sizes categorized by the Project type

it can be notices notice from the figure that the highest number of projects is the large size project, followed by the medium, then the small projects, then very large and then the lowest number of project is mega projects. This indicates that Egypt still considered a large size project market, which needs to be expanding to accept mega project types.

The contract type categorized by project's type is shown in Fig .4.4

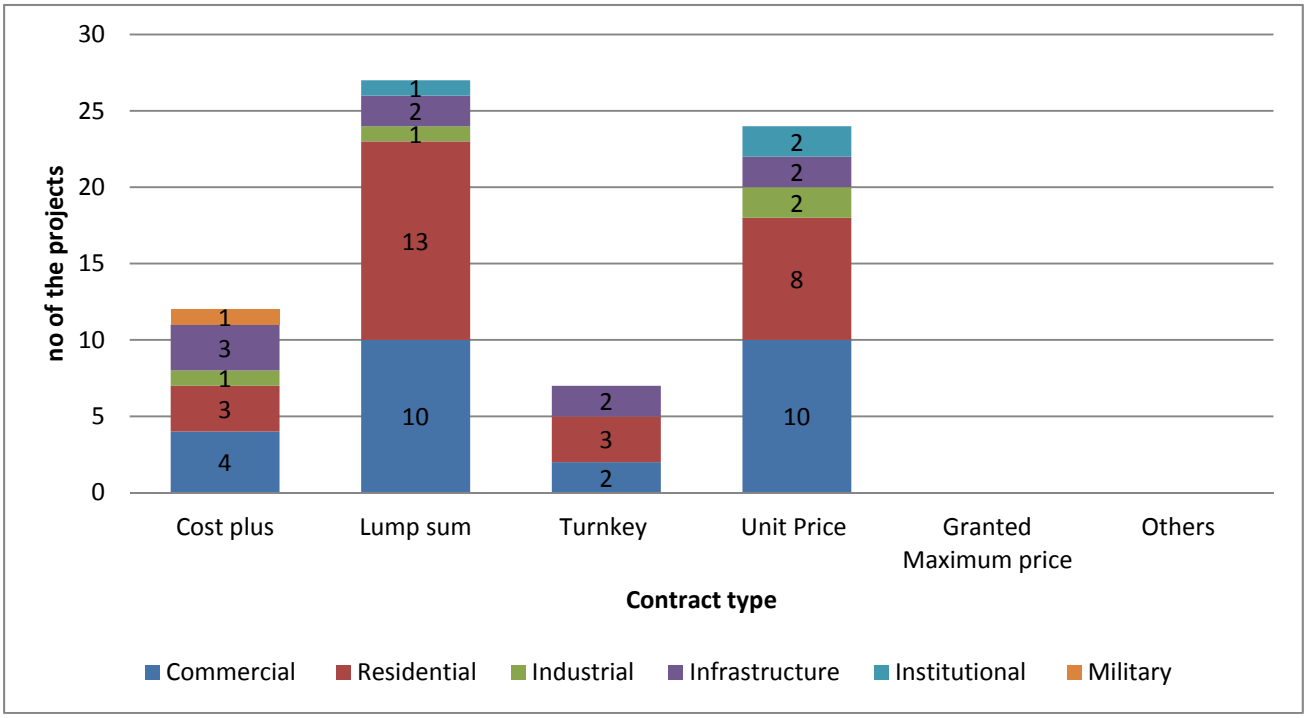


Fig. 4.4 The contract type categorized by project's type

It can be noticed from the figure that the highest number of projects came from lump sum project (27 projects), followed by unit price (24 projects), then cost plus (12projects), then finally turnkey (7 projects) and zero projects for GMP(granted maximum price) and others types. This indicates the most common types used in Egypt are lump sum and unit price. While still the other types of contracts are not spread.

The distribution Percentage for the types of the project's Owner are shown in Fig.4.5

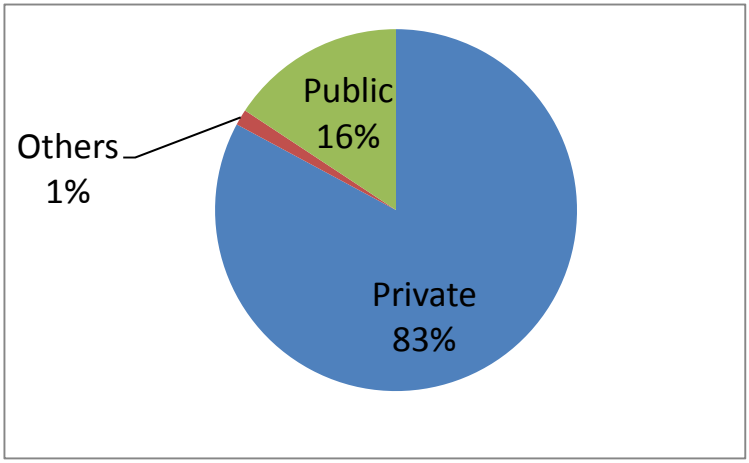


Fig. 4.5 Distribution Percentage for the types of the project's Owner

The distribution of Construction type categorized by the project type is shown in Fig. 4.6. We have three construction types: New, Addition / Expansion and Renovation.

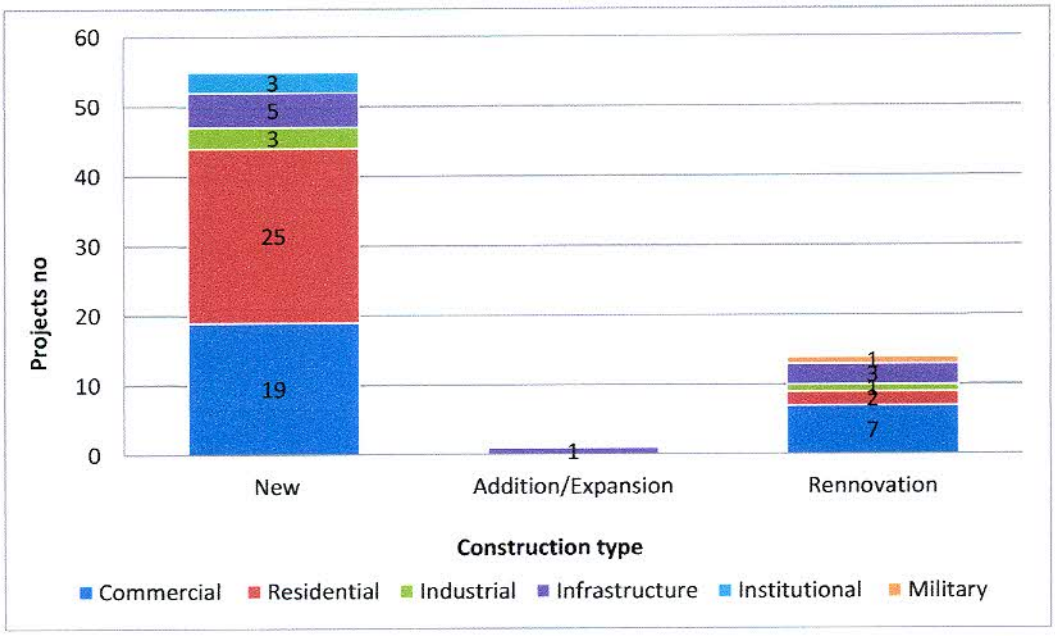


Fig.4.6 Distribution of Construction type categorized by the project type

From the Fig. 4.6. We can notice from the chart that the highest number of projects came from *new* construction type which represents 79% of the total number of projects collected, while the *Additional/Expansion* is the lowest number of projects which represent 1.4 % of the total number of projects.

4.3.2.2 Part two; Change order data

Average percent of Change Order initiated categorized by parties are shown in Fig. 4.7

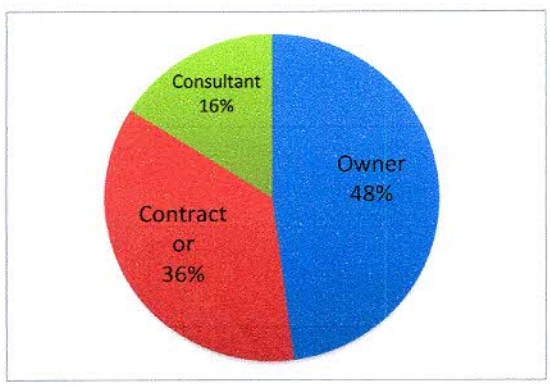


Fig. 4.7 Average percent of Change Order initiated categorized by parties

From the Figure we can notice that the highest numbers of change orders initiated by the owner (48 percent), followed by the contractor (36 percent) and the lowest number of change orders initiated by the consultant (16 percent), the distribution of percent indicate that the main initiator of the change is the owner, this can be taken in consideration in controlling the change orders issued.

The distribution of the Change order‘s initiator percent categorized by project type is shown on Fig. 4.8

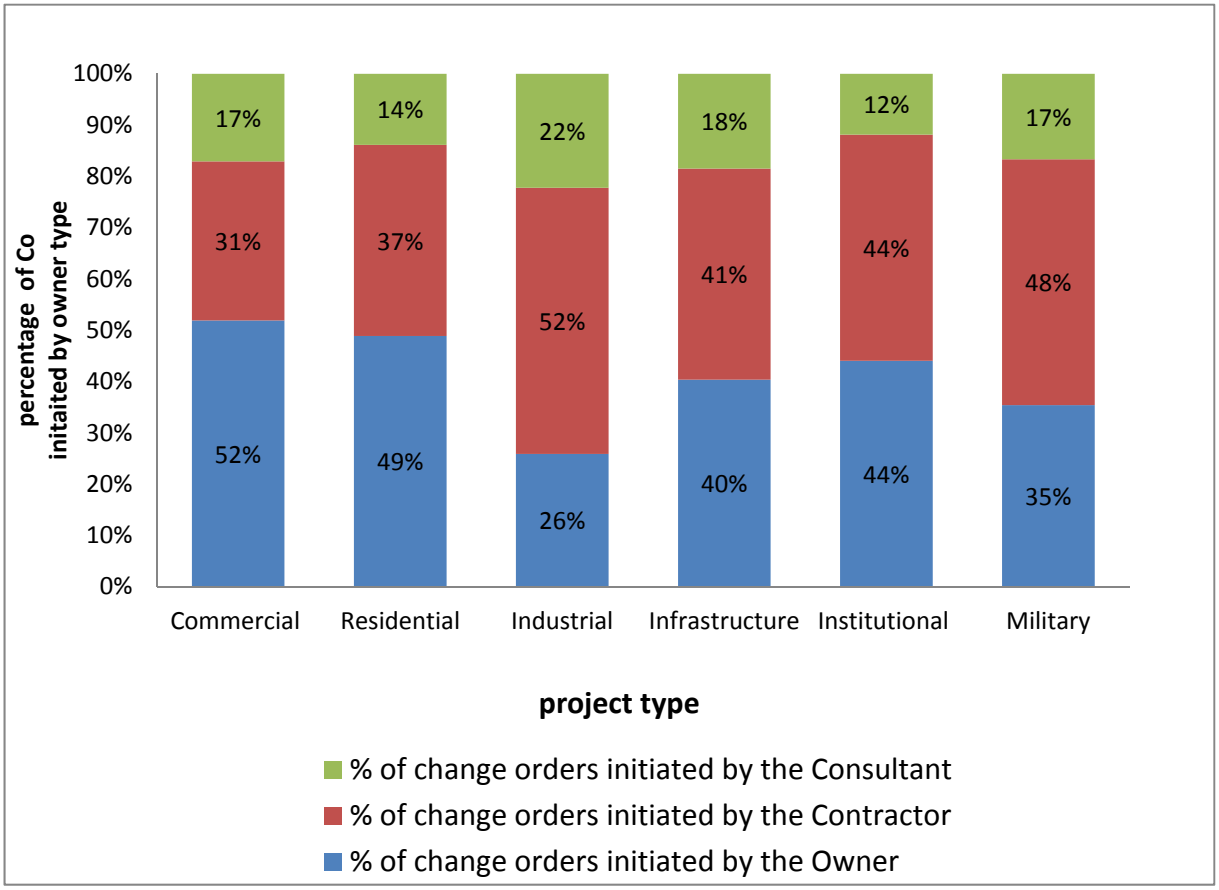


Fig. 4.8 distribution of the CO‘s initiator % categorized by project type

From the Figure 4.8, we can notice that the percent for the change orders initiator differ according to the project type. For the industrial, infrastructural and military project type the change orders initiated by the contractor is the highest while for the commercial and residential project type the change order initiated by the owner is the highest. This might refer to other factors as the owner type and contract type or the complexity of the project.

The distribution of the Change order‘s initiator percent categorized by construction type of project is shown on Fig. 4.9

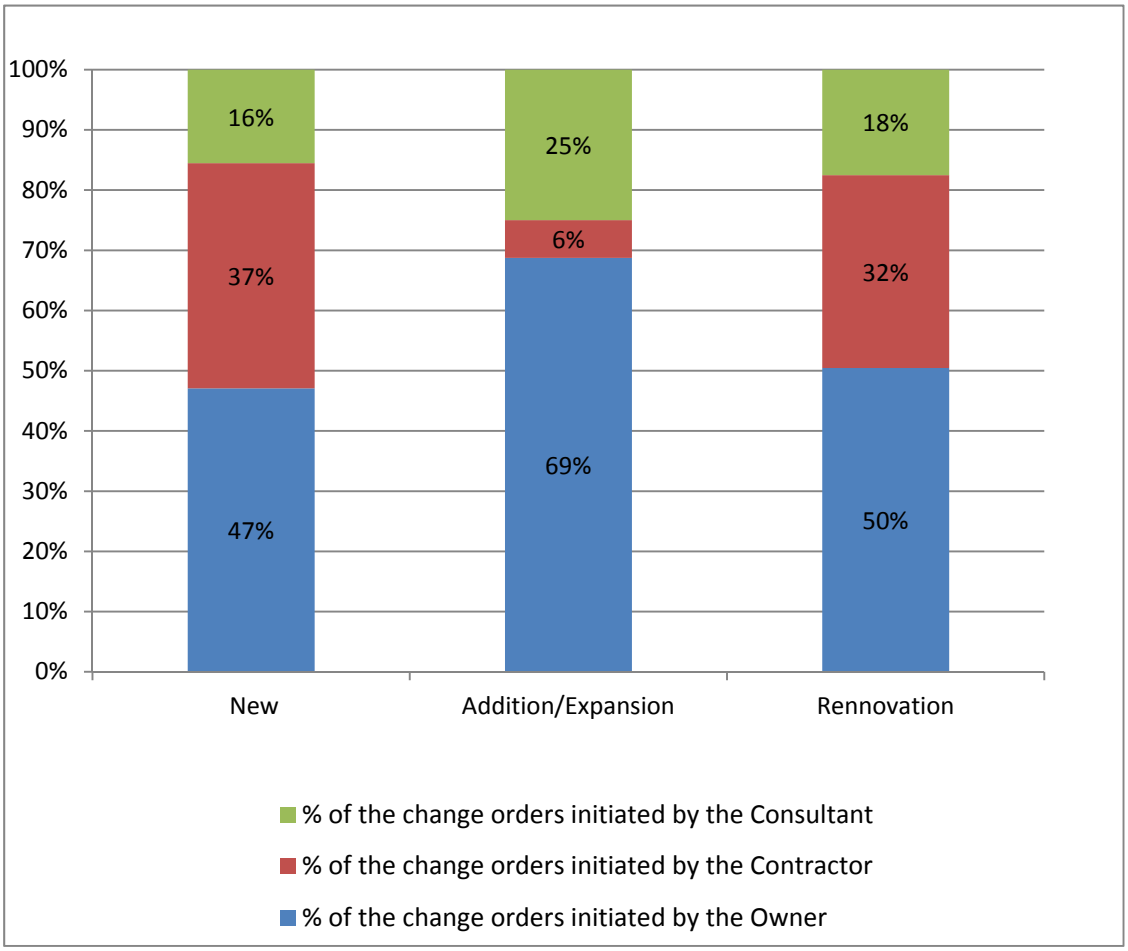


Fig. 4.9 distribution of the Change order‘s initiator percent categorized by construction type of project

From the previous Figure, we can notice that the percent for the change orders initiator differ according to the construction type. But the owner remainsthe same highest initiator with just different percent, while for the two other initiators (contractor and consultant) the percent vary sometimes the contractor became the second initiator as for *new* and *renovation* and became the lowest initiator in the *add/expansion* project type.

The respondents commented that the percentage of change orders’ initiators depends on the construction type of project and another unforeseen conditions.

The distribution of the Change order‘s initiator percent categorized by Contract type is shown on Fig. 4.10

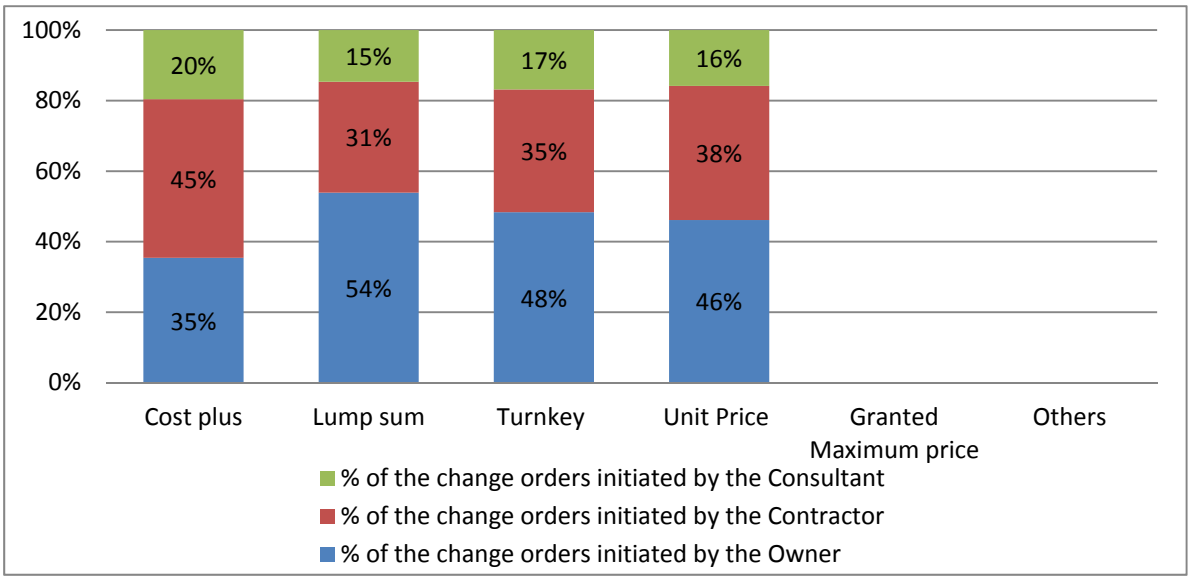


Fig. 4.10 The distribution of the Change order‘s initiator percent categorized by Contract type

From the previous Figure, we can notice that owner is considered the highest initiator for all types of contract except for the cost plus contract type the contractor is higher.

The distribution of the Change order‘s initiator percent categorized by Owner type is shown on Fig.4.11

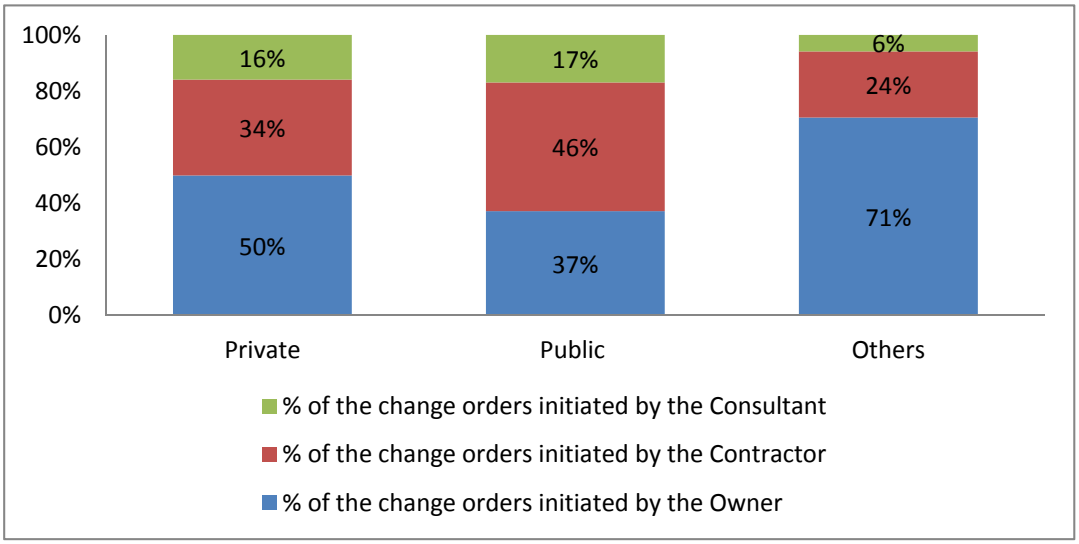


Fig 4.11

The distribution of the Change order‘s initiator % categorized by Owner

From the previous Figure, we can notice that owner is considered the highest initiator for private and others owner's type but for the public ones the contractor is considered the highest one, this might be refer that in the public type the important driven factor is time or dense regulation for change in the public sector .

The compensation method for the change order is shown on Fig.4.12

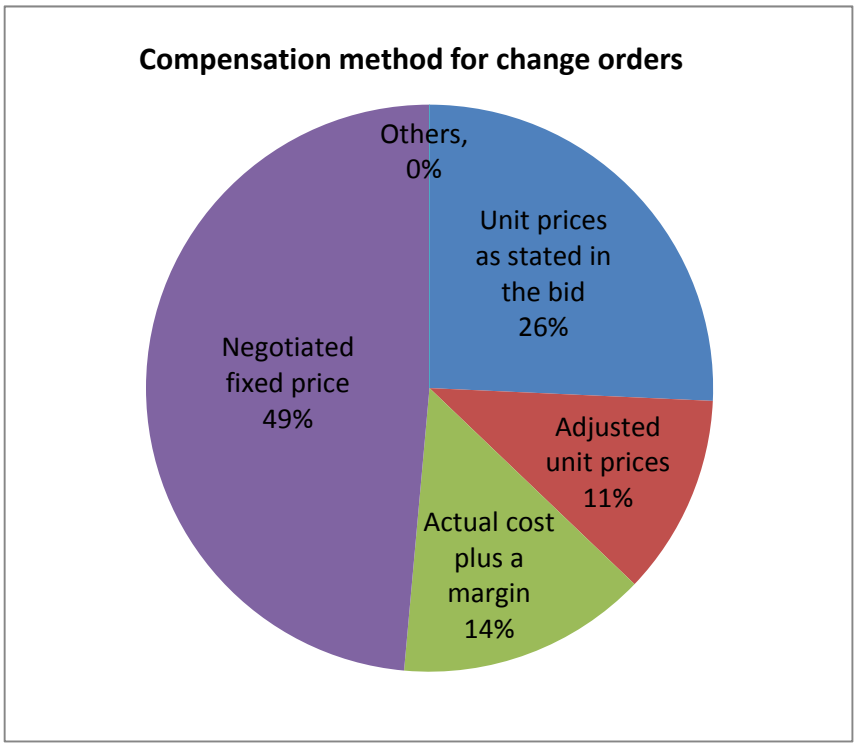


Fig.4.12 Compensation method for change orders

The percentage of respondents is shown on y- axis and type of compensation is shown on the x-axis.

Survey questionnaire included five choices for the method of compensation, *Unit prices* as stated in the bid, *Adjusted unit prices*, *Actual cost plus a margin*, *Negotiated fixed price (Lump sum)* and *Others.*

Forty nine percent (49 %) of the respondents said that the compensation of the change order usually is Negotiated fixed price (Lump sum), Twenty six percent (26 %) indicated that the compensation of CO is Unit Prices as stated in the bid, fourteen percent (14 %) for the Actual cost plus margin and eleven

percent (11 %) goes with adjusted unit prices. None of the respondent reported other techniques than stated in the questionnaire.

From the previous figure we can notice that that the most common method for compensation is the *Negotiated fixed price* (Lump sum).

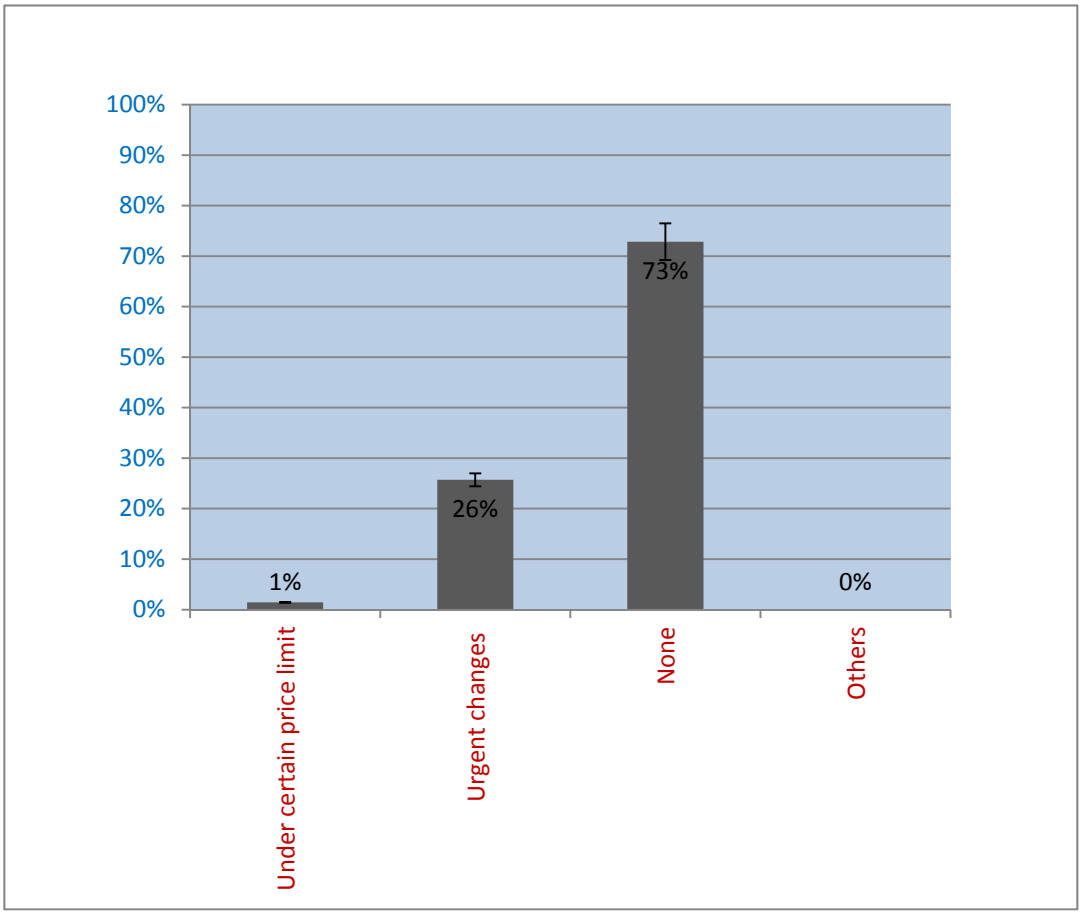


Fig.4.13 The percentages for change order proceeds without written approval

Fig .4.13 shows the percentages for change order proceeds without written approval. From the Fig.4.13, we can notice that seventy six percent (73%) of the respondents said that the only way to proceed with the change order is the written approval, while twenty six percent (26%) said that the urgent changes might proceed without written approval and only one percent (1%) said that under certain price limit, the change order might proceed without written approval. This results emphasizes that the verbal instruction is not accepted and if so it will be for urgent changes only and done by the employer only under specific conditions.

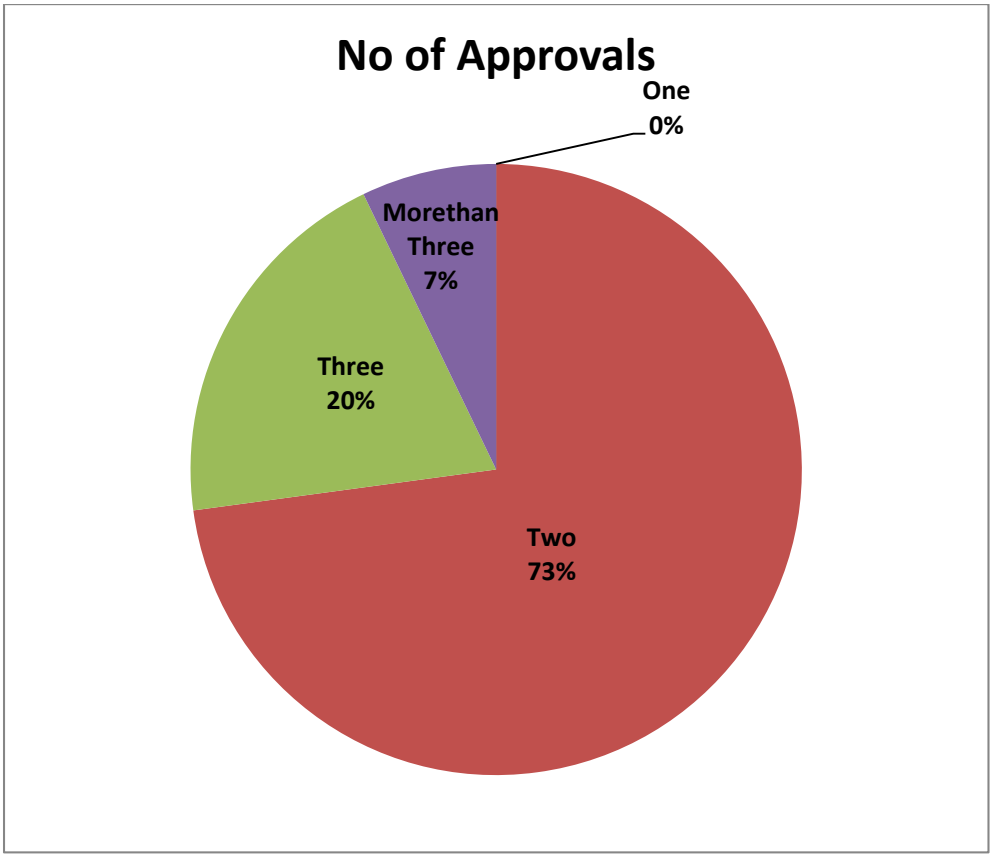


Fig.4.14 The percentages for how many approvals are required for change

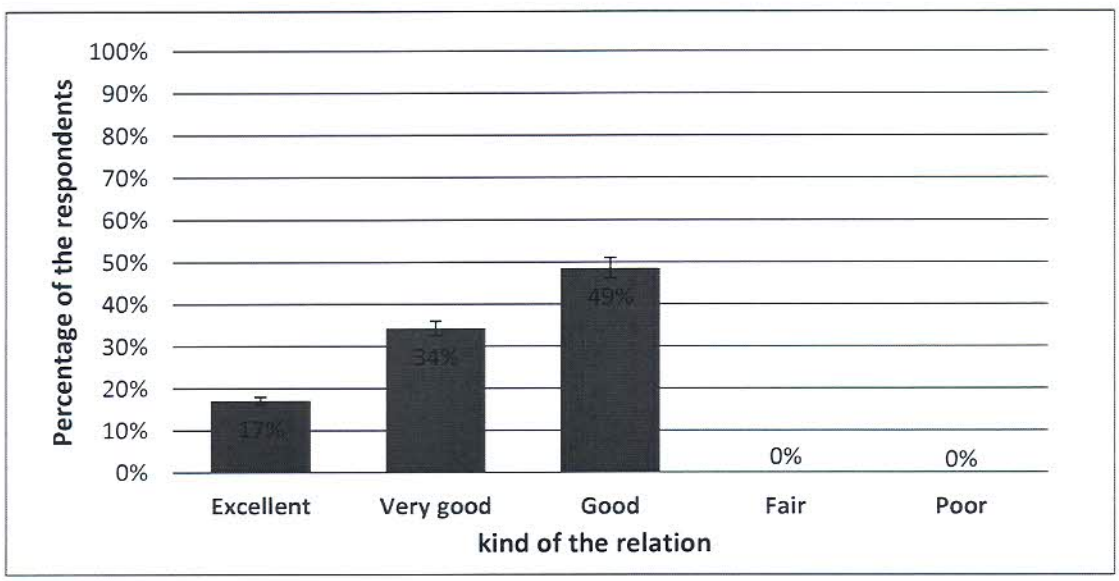
The percentage of how many approvals are required for change orders is shown in Fig.4.14.

From the previous figure, we can notice that most of the respondents, about 93% (73 % from two numbers of approval required and 20 % from the three numbers of approvals required) said it is between 2-3 approvals required for change order. While none of the respondents choose the first option (only one approval is required) this indicated that the change order is such an important documents that needs more than one level of responsibilities to revise it.

Fig .4.15 shows the histogram of the relation between the principal parties in the construction process, *owner*, *contractor*, *consultant* and *the project manager*. The different kinds for the working relation (*excellent, very good, good, fair* and *poor*) are on the x-axis and the percentage of the respondents decision are on the y-axis).

From the results shown on the figure, we can notice that 51% of the respondents had chosen either *excellent* or *very good relation* for the working relation between principal parties and the rest (49%) chosen *good*, while none of respondents stated that the relation can be fair or poor. This indicates how the working relation between parties is very important to the benefit of any project and how all the parties agreed to have a good working relation. This factor is considered very important in the management of any construction project.

Fig.4.15 Working relation between principal parties



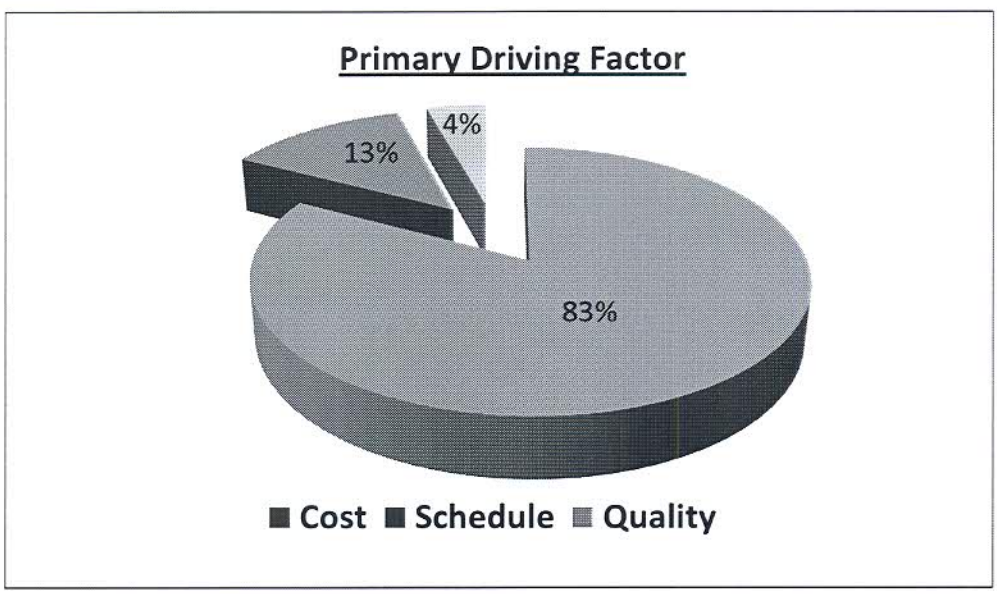


Fig.4.16 The primary driving factor for change orders

The primary driving factor for change orders is shown in Fig.4.16, The three choices stated in the survey questionnaire included: *Cost, Schedule* and *Quality*.

From the figure we can notice that eighty three percent (83%) of the respondents said that the cost is the most driving factor for change order. While thirteen percent (13%) of the respondent said that the schedule is the driving factor and only four percent (4%) of the respondents said that the quality is the driving factor for the change orders. This indicates that the most driving factor for the change order is the cost.

The distribution of the change order that generated from the different construction craft (*Architectural, structural, Electrical, Mechanical and Finishes*) is shown on Fig.4.17. As seen from the histogram, we can notice that about sixty eight percent (49% mechanical and &19% from electrical) of the respondents considered that electro-mechanical is the most change order generating craft. These results are quite expected considering the nature of building projects.

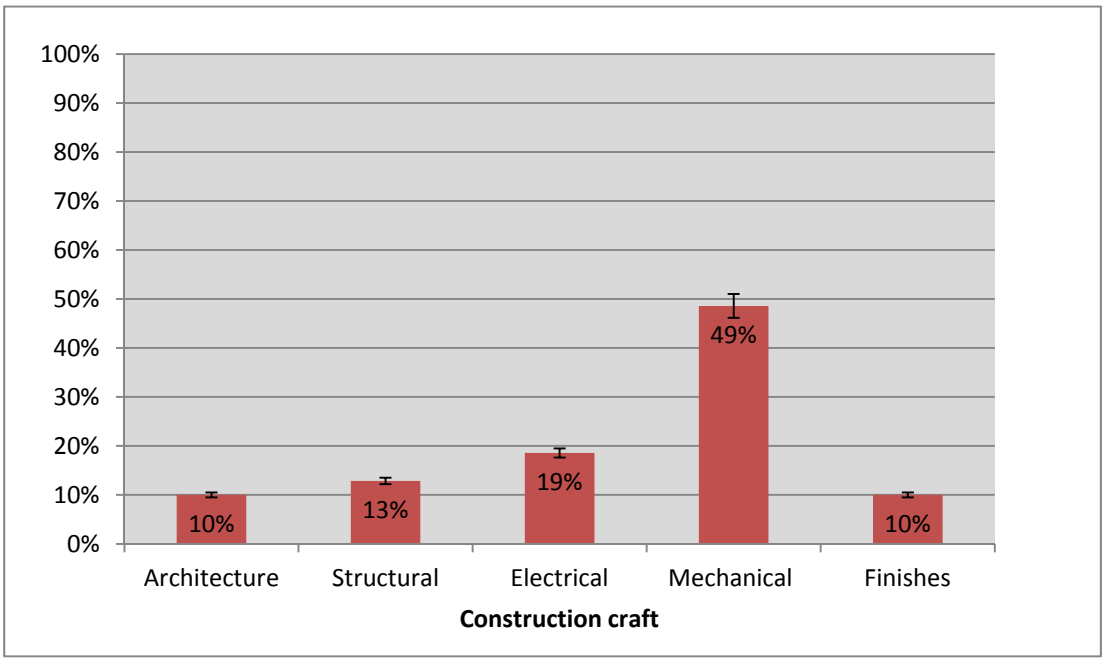


Fig.4.17 The percentage of the change order generated from construction craft

4.3.2.3 Part three; Causes leading to the change order

The responses on the causes of change orders will be looked at from all perspectives. For all respondents we will report the most important causes. The Importance Index was calculated. As discussed earlier we will also look at the categories of causes, owner generated, contractor generated, design or consultants generated, and other causes. Causes will be ranked and categorized based on the importance index reported.

Table 4.1 below shows the causes of the change orders as extracted from the literature review, ranked based on its importance. Each respondents was asked to the choose the top five causes in order, then the researcher collect the number of counts recorded for each factor categorized by priority. For example factor no11 (safety *consideration*) , seven respondent chosen it as 2^{nd} important factor, and two respondent chosen it as the 3^{rd} important and only one respondent chosen it as 4^{th} important. This step followed by the relative index, where the researcher added the importance (1^{st}, 2^{nd} , 3^{rd} , 4^{th} or 5^{th}) to the count number and calculate the average for each factor , example for same cause number 11 (*safety consideration*) ; RI = seven was multiplied by the 2^{nd} important relative factor which is 4, two was multiplied by the 3^{rd} important relative factor which was 3 and one was multiplied with 4^{th} important relative factor which was 4, all of them were added and average were calculated which is 2.4 .

Finally the causes were ranked based on their relative index, example factor number 11 were ranked the ninth among all factors.

Table 4.1: The importance relative indexes of causes

no	Factor / Rank	Count NO					RF	Rank
		1	2	3	4	5		
1	Change of plans by owner	2	6	3	8	13	0.09	5
2	Owner change of schedule			1	3	7	0.03	10
3	Substitution of material or procedures			13	3		0.05	7.5
4	Conflict between contract and document		5	5	2	1	0.04	9
5	The scope of work for the contractor is ill-defined		1		1	2	0.01	17.5
6	Contractor desire to improve his financial conditions		1	9	1		0.03	12
7	Error and omissions in design	22	9		10	2	0.12	2
8	Contractor financial difficulties					2	0.01	20
9	Unavailability of skills					1	0.00	21
10	New government regulations					4	0.01	17.5
11	Safety consideration		7	2	1		0.03	12
12	Technology change				1	9	0.03	12
13	Owner financial difficulties			4	4	5	0.03	14
14	ill –defined project objective			1	1	3	0.01	16
15	Change in design	5	14	3	11	2	0.10	4
16	Lack of coordination	34	7	4	2		0.13	1
17	Value engineering	7	15	4	10	7	0.12	3
18	Differing site conditions		1	5	5	5	0.05	7.5
19	Unavailability of equipment				3	4	0.02	15
20	Defective workmanship		4	15	3	2	0.08	6
21	Weather condition			1	1	1	0.01	19

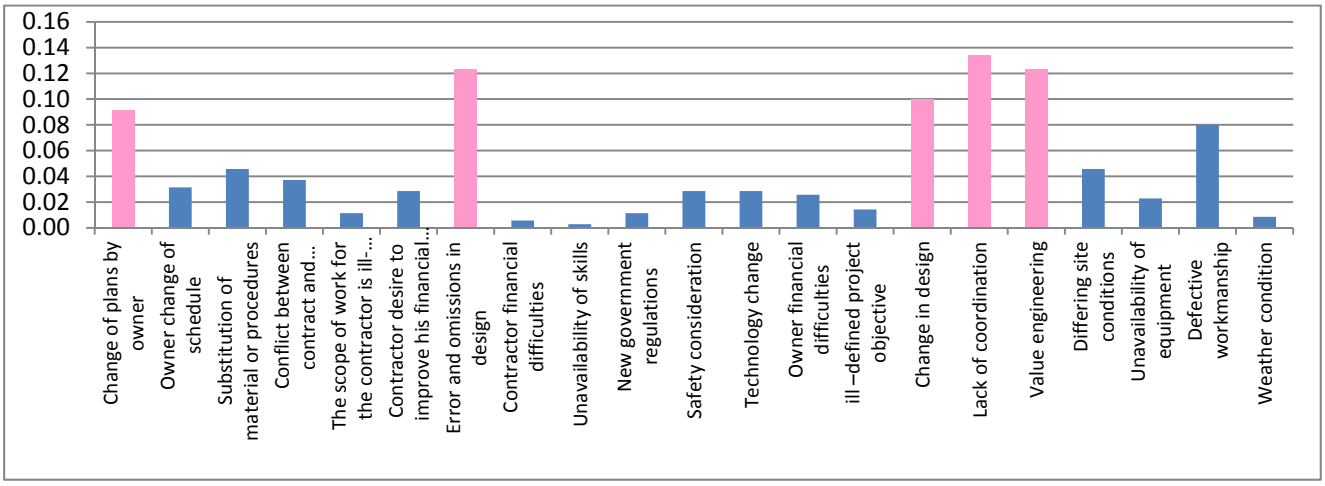
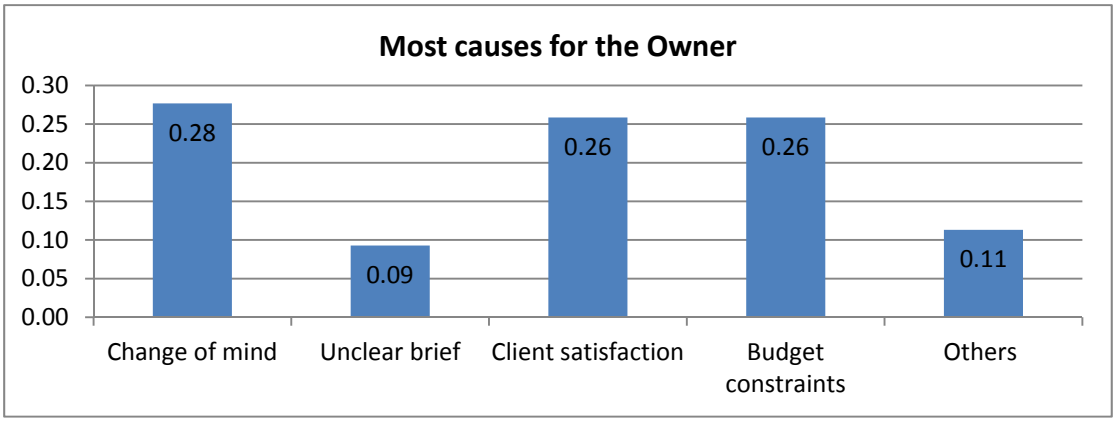


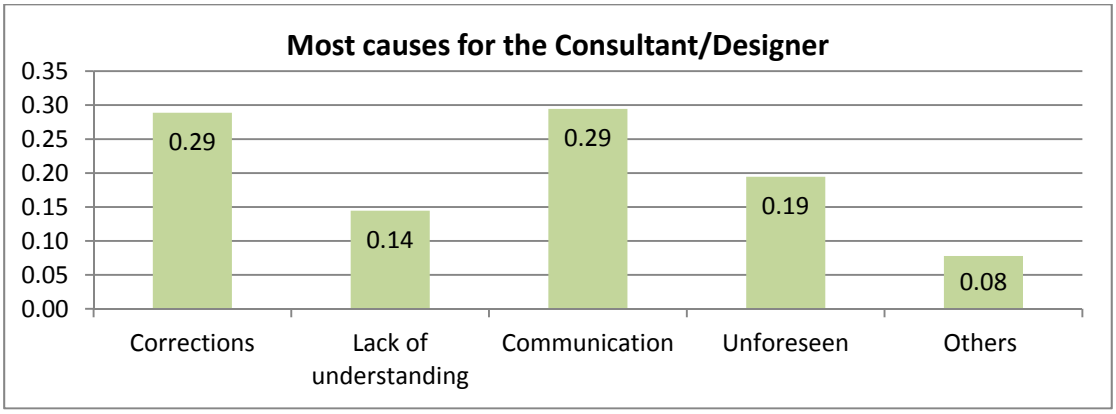
Fig.4.18 The relative indexes for each cause of the change

Fig .4.18 shows the relative indexes for causes of the change orders, the causes are on the x-axis while the relative indexes are on the y-axis, for example causes number seven, the *error and omissions in design* has about 0.11 for the relative indexes. From the figure above we can conclude the most important top five causes are as follows highlighted in pink:

	The most top five causes
1	Lack of coordination between contractor and consultant
2	Error and omissions in design
3	Value engineering
4	Change in design
5	Change of plans by owner

It might be noted that the causes stated above are originated by all parties. Going deep through the causes originated by each party separately, fig. 4.19 shows the most normal causes for each party, the relative index for each cause is calculated using the same technique stated before for the importance of the causes and hence the causes were ranked based on the importance index reported.





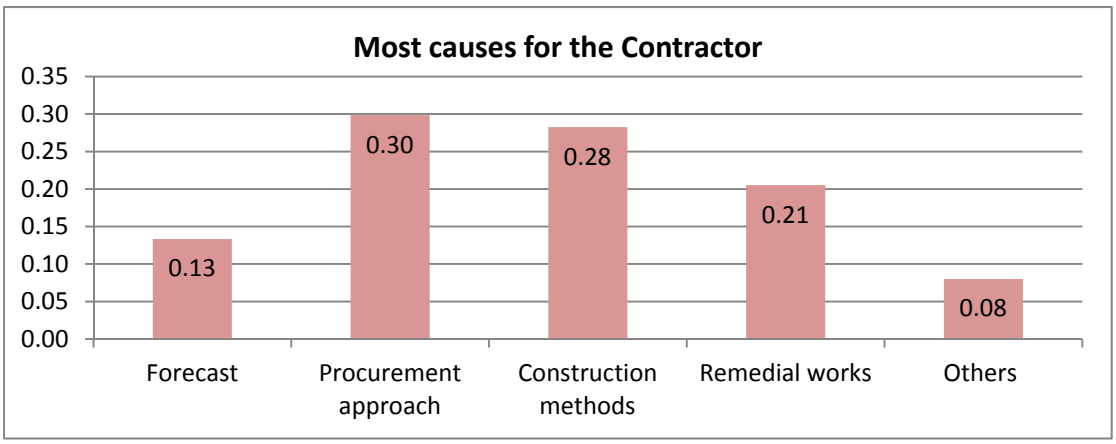


Fig.4.19 The relative indexes for causes for each party

Hence, as evident from above table, the causes of change order's generation in descending order for each agent :

The Owner

1	Change of mind
2	Client satisfaction
3	Budget constraints
4	Others
5	Unclear brief

The Designer or the Consultant

1	Communication
2	Corrections
3	Unforeseen
4	Lack of understanding
5	Others

The Contractor

1	Procurement approach
2	Construction methods
3	Remedial works
4	Forecast
5	Others

Fig .4.20 shows the histogram for the percentage of the owner involvement in the construction projects. The level of owner involvements is expressed in terms of the stages the owner gets involved in the process of design and construction of the project.

From the figure, we can notice that 44% of the responded said that the owner gets involved in both design and construction stages, 30% said that the owner gets involved in the design stage only, 24% indicated that the owner gets involved in the construction stage only and 1% indicated that the owner does not involved.

From the results we can conclude that almost all the respondents (99%) agreed that the owner got involved and the majority (44%) chose that normally the owner got involved in both stages design and construction.

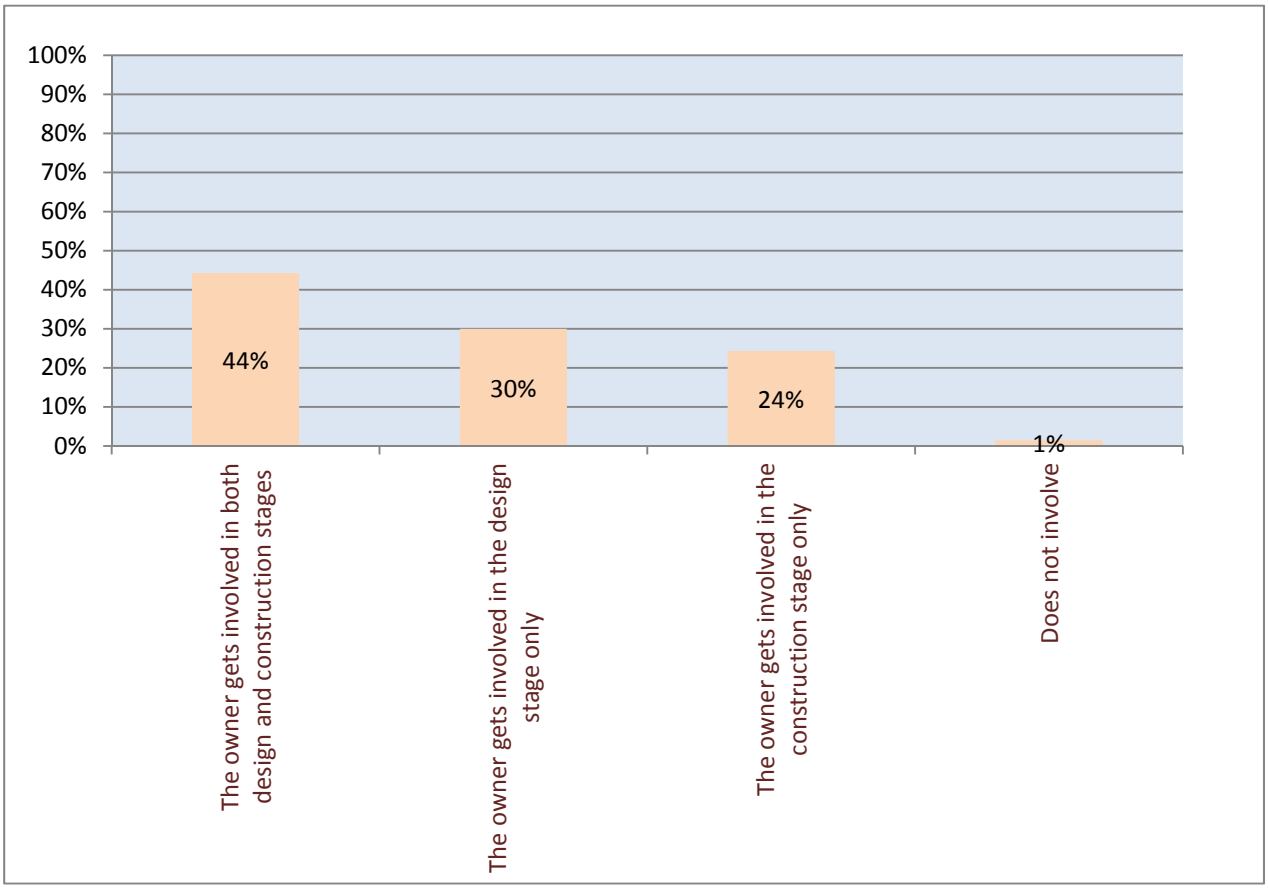


Fig.4.20 The percentage of the owner involvement during project stage

4.3.2.4 Part Four; Impact of the change order

In this section the researcher examined the overall response on the effects of change orders in large building projects in Egypt.

Fig.4.21 below shows the histogram of the percent increase in the project cost due to the change orders. Cost overruns as a percentage of original contract value is classified into six categories, Below 0% (Saving), from 0 to 5%, from 6 to10%, from 11to15%, from 16 to 20% and more than 20%, categorization was based on the what had been concluded from the literature review and stated on the questionnaire survey.

From the Fig.4.21, we can notice that forty one percent (41%) of the respondents said that the percent increased due to change orders as an average between 11 and 15% of the total project cost, while thirty percent (30%) of the respondents said that the percent increased due to change orders as an average between 6 and 10 %, sixteen percent (16%) of the respondents said that the percent increased due to change orders as an average between 0 and 5%, ten percent (10%) of the respondents said that the percent increased due to change orders as an average between 16 and 20% and only three percent (3%) reported the percent increased due to change orders is more than 20%.

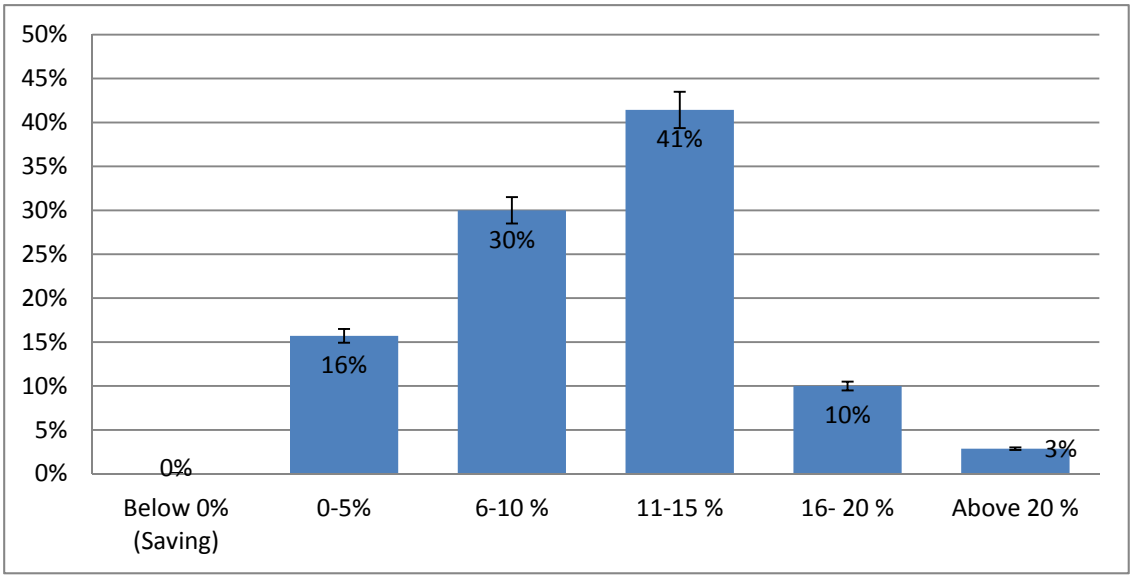


Fig.4.21 The percentage increase in the project cost due to the change orders

From the previous figure we can concluded that the cost of the project increased as an average between 11 to 15 percent due to change orders. These percent increases in the few past years due to a lot of conditions, most of which is related to the causes that always changes.

Fig.4.22 shows the percent increase in schedule due to change orders. Schedule overruns as a percentage of the original schedule are classified into four categories, first category is less than 10%, second category is between 10% and 20%, third category is between 21 and 50 percent, forth category is more than 50%.

From the figure, we can notice that over forty five percent (45%) of the respondents said the percent increase is from 10-20% of the original schedule, while forty three percent (43%) said the schedule overrun is between 21 and 50% of the original schedule and less than ten percent (10%) said the increase is less than 10%.

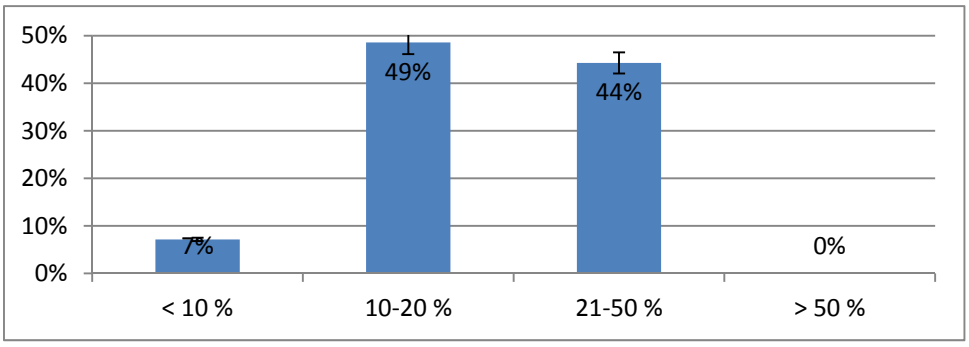


Fig.4.22 The percentage increase in schedule due to change orders

From the previous figure we can concluded that the time of the project increased as an average from 10 to 20% of the original scheduled time due to the change orders. This percentage is considered to be a quite significant impact that must be considered from all the parties.

Fig.4.23 below summarizes the results of respondent who participates in the survey on the most prevalent effects of the change orders on their large building projects. the relative indexes are calculated for each effect based on

their importance indexes and ranked then most effects of the change orders prevalence are stated.

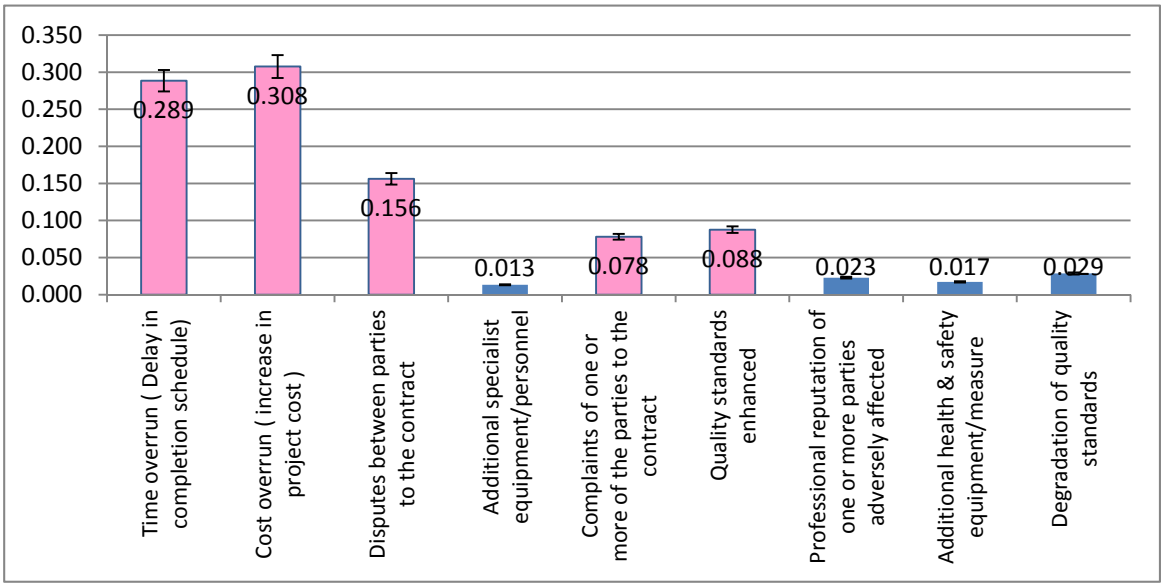


Fig .4.23 The most prevalent effects of the change orders

Hence, as evident from previous figure , the top five effects (prevalence) of change orders in descending orders are

1. Cost overrun (increase in project cost)
2. Time overrun (Delay in completion schedule)
3. Disputes between parties to the contract
4. Quality standards enhanced
5. Complaints of one or more of the parties to the contract

4.3.3. Section (C)

4.3.3.1 Management and controls of the change orders

In this section, the research examined the responses from the contractors, consultants, designers and the others on the change orders process control and management.

Fig.4.24 shows the percentage of respondents that agreed to have a clause for variation orders rules and procedures as an essential feature of any construction contract.

From the chart wen can notice that 89% agreed to have a clause that regulate change orders as an essential feature of any construction contract.

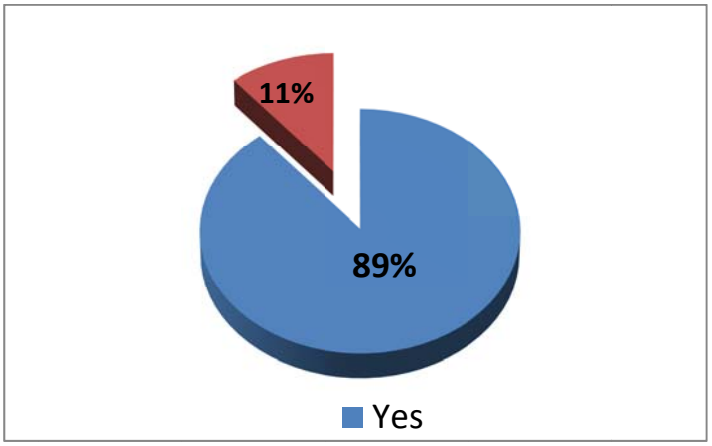


Fig.4.24

The percentage of respondents agreed to have a contract clause for change orders

This percent reflect the importance of keeping a clause for change order and how to manage it for all types of contracts.

Fig.4.25 is a graphical presentation for the relative importance of the change order success factors. The relative indexes is calculated for each factor based on the importance index then ranked based on the relative indexes and the top five effects certain success factors for change orders implementation are extracted.

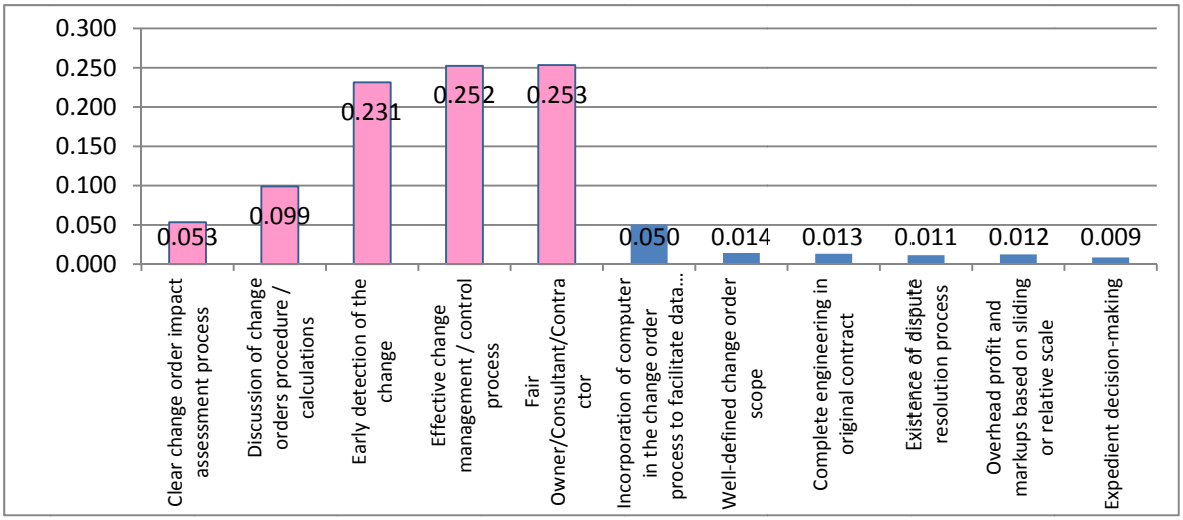


Fig.4.25 The relative indexes for the most important factors for change orders implementation

The five most certain success factors for change orders implementation in descending order

a) Fair Owner/Consultant/Contractor
b) Effective change management / control process
c) Early detection of the change
d) Discussion of change orders procedure / calculations
e) Clear change order impact assessment process

Fig.4.26 shows the percentage of the respondents that use a well-defined change order management system.

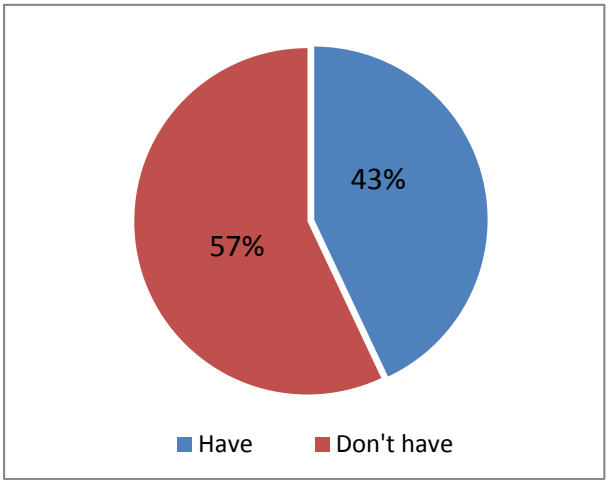


Fig.4.26
The percentage of using a well-defined change order management system

From the figure we can notice that 57% of the respondents said that they have a well-defined system for change order process while 43 percent respond that they don't have. This significant percentage of not having a well-defined system reflects the increased number of cost and schedule overrun due to change order and hence conform the essential needs of having a well-defined system for handling the change orders.

Fig.4.27 shows the percentage of the results of respondents who participates in the survey on change order administration and control :

Survey questionnaire included five choices for each point written in order as follows:

1. Very Often,
2. Often,
3. Sometimes,
4. Seldom,
5. Never.

The Likert Scale of measurement were used for transforming qualitative to quantitative, Responses to this section of questionnaire were then analyzed.

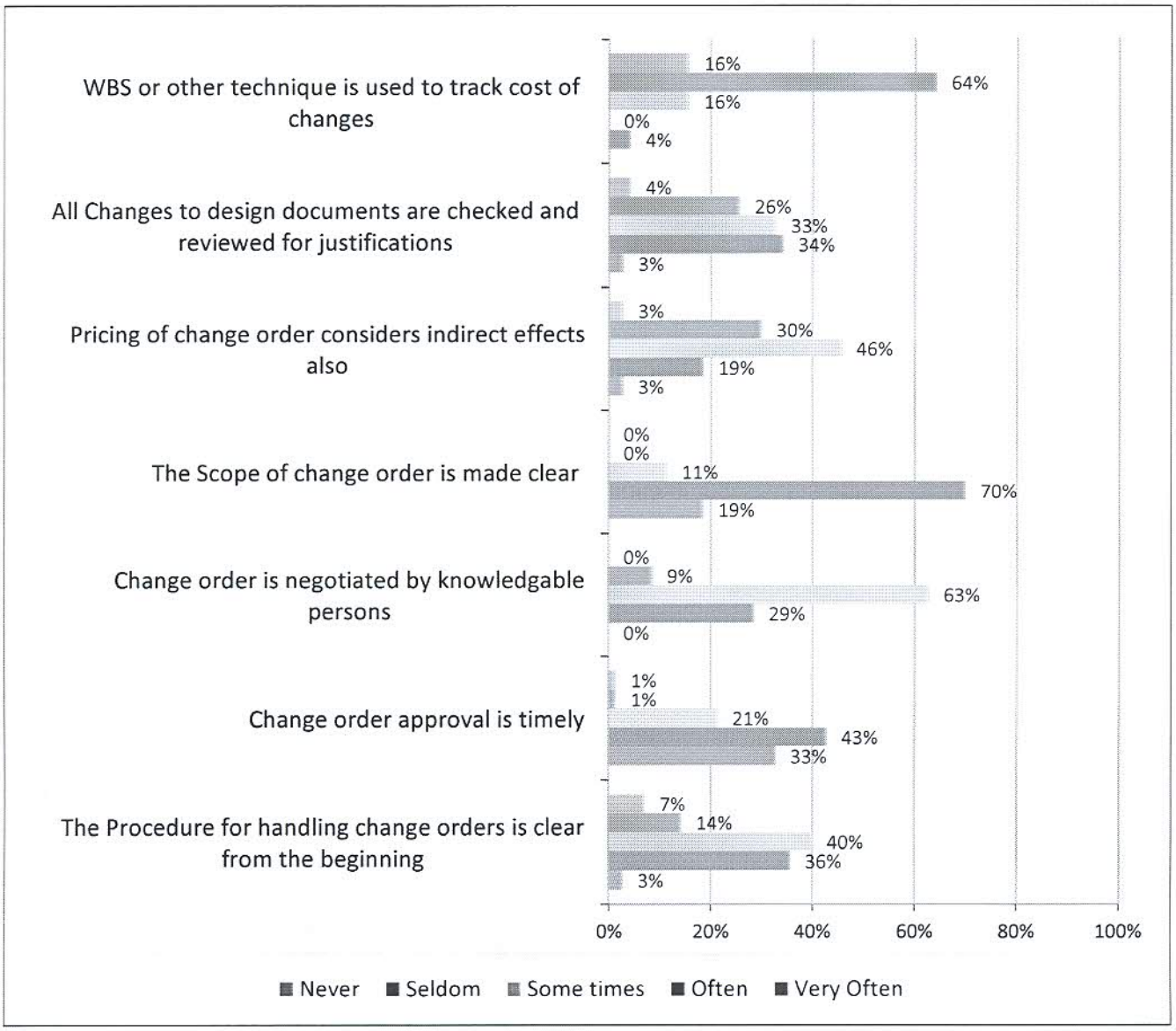


Fig 4.27 The percentage of the results of respondents who participates in the survey on change order administration and control

From the previous figure we can concluded that ; Regarding the clear procedure for handling the change order from the beginning of the project, seven percent (7%) said that it is very often to have a clear procedure for handling change orders from the beginning while fourteen percent (14%) said it is often, forty percent (40%) said that it is sometimes, thirty six percent (36%) said it is seldom and only three percent (3%) said it is never to have a clear procedure for handling change orders from the beginning. We can notice that most of the respondent about seventy six percent (76%) replied that it is either sometimes or seldom having a clear procedure for handling the change order which emphasizes that up till now, having a clear procedure for the change order from the beginning of the project is not taken in consideration which if taken will definitely eliminate the impact for the change order.
Regarding the change order's approval is a matter of time, one percent (1%) said that it is very often that change order approval is timely, Another one percent (1%) said that it is often, while twenty one percent (21%) said that it is sometimes, forty three percent (43%) said that it is seldom and only thirty three (33%) said never to consider change order approval is timely.
We can conclude that the majority (about 76%) said it is never or rarely consider the approval of change order is a matter of time. This conclusion leads to have a well-organized system should be established for the approval procedure.
For the Change order's negotiation, none of the respondents said that it is very often that change order is negotiated by knowledgeable persons, only nine percent (9%) said it is often, while the majority, sixty three percent (63%) said that it is sometimes, twenty nine percent (29 %) said that it is seldom and none of the respondents said that it is never to consider change order is negotiated by knowledgeable persons. This conclusion confirm the need of letting the negotiation of change order to be done by a well knowledgeable person.
For the scope of change made clear, none of the respondents said that it is very often nor even often that the scope of change order is made clear, only eleven percent (11 %) said that it is sometimes, while the majority, seventy percent (70 %) said it is seldom and 19% of the respondents said that it is

never to consider scope of change order is made clear. One of the main factors needed to be clarified is the statement of the change order, the change order scope should be very clear and covering all the requirements. And from the result shown this factor show be taken in consideration to avoid the impact that might be raised due to ignoring it.

Regarding whether the pricing of the CO considers the indirect effects, only three (3%) of the respondents said that it is very often that the pricing of change order considers indirect effects also, thirty percent (30%) said it is often, forty six percent (46%) said that it is sometimes, nineteen percent (19%) said that it is seldom and only three percent (3%) said never considered. This factor needs to be highlighted as the results shows that it is barely taken in consideration and can be considered as commonly mistake.

Regarding whether all changes to the design are checked and reviewed for justification, four percent (4%) of the respondents said that it is very often that all changes to design documents are checked and reviewed for justifications, twenty six percent (26%) said that it is often, thirty three percent (33%) said sometimes, thirty four percent (34%) said it is seldom and only three percent (3%) said never considered.

Finally, for any technique used to track the cost of the change, sixteen percent (16%) of the respondents said that it is very often that WBS or any other techniques is used to track the cost of changes, while majority , sixty four percent (64%) said it is often, sixteen (16%) said sometimes, none of the respondents said it is seldom and only 4% said it never to consider that that WBS or any other techniques is used to track the cost of changes. This result is considered to be good and need to be sustained.

CHAPTER FIVE
EVALUATION OF CHANGE ORDER MANAGEMENT PROCESS WITHIN CONTRACTOR ORGANIZATION

Chapter Five

Evaluation of change order management process within the contractor's organization

5.1 Introduction

Out of the received questionnaires, twenty seven were contractors, each of which represents a project. Out of these projects, four projects were selected for evaluation regarding the management efficiency for the change management. The selection of these projects was based on the following criteria; first, at least one project should represent project types (Commercial, Residential, Industrial, Infrastructure and Institutional). Second, the project construction type should be new as it represents the majority of the project collected (around 80%). Third, the owner to be private which represent eighty three percent (83%) of total project owner type. Fourth, the contract type to be unit price as it is the most popular and common contract type used. Regarding the Infrastructure projects, only two projects are considered to be new, out of which, only one of them have a private owner which found to have turnkey contract type, for that the this type was excluded. The details of these projects are listed in Appendix (C).

5.2 Evaluation

In order to evaluate the change management control process among the selected projects, the researcher prepared an evaluation check list and applies its content over the selected projects. The check list preparation was based on the preferred effective principle for the change management system presented in chapter two together with the most appropriate respond of the questionnaire.

5.2.1 Evaluation criteria

The process of determining the feasibility for any management system is based on applying technical evaluation criteria that have been found to be good indicators of whether the company or contractor have a good control system regarding the change in work process or not. The purpose of this section is to present the evaluation criteria. As a minimum, the detailed

evaluation stage will evaluate the following criteria; keywords for effective change management process that will be evaluated are; *Recognize Change, Evaluate Change, Implement Change & Improvement*. Each of the keywords mentioned have a direct impact over management process and therefore was considered. In the following lines, the researcher will try to state the objective(s) of each criteria and its scoring points;

a- "*Recognize Change*", The contract documents (Contract, Specifications, drawings & B.O.Q) identify the requirements for the project in terms of its scope, schedule, and budget. The contract requirements must first be identified so that any deviation can be recognized. The objectives needed to ensure that are to make sure that company (contractor) can identify the change , this was done thru identifying the following;

- The ratio of the CO initiated by the Contractor to the Consultant or Designer, if the number of change orders initiated by contractor exceeding the number of the CO initiated by consultant or designer, this will indicate that the contractor has a well experience technical team studying the project well together with the side condition and can recognize change easily, which will lead to the benefit of the project. For the scoring as the percentage is directly proportion to the effective control system for change, the percentage will be stated as a it is for ease.
- The ratio of change orders initiated due to the discrepancies between documents (drawings, specifications & B.O.Q) with the other change orders initiated due to differ in site conditions, if the number of the change orders initiated due to the discrepancies of the documents exceeding the number of the change orders initiated due to differ in site condition, this indicate that despite the differ site condition, the company (contractor) has the ability to identify the potential change.

Both ratios will give the indication of whether the company can identify the change or not.

b- *Evaluate Change*, main objectives are determine entitlement, measures the effect of the change, and calculates the cost of the change. The

methods needed for evaluating the change order can be achieved by the identifying ;

- The procedure for handling the change order from the beginning of the project is well clarified or not , this will indicate whether the company (contractor) has a well-defined system for the change order together with the ability of the company (contractor) to manage the change order in from the beginning of the project (preconstruction phase) or not. The scoring of this objective vary from one company to another, that was covered through the survey, the researcher give each one of the respond scale a score, despite the answer “Never” = 0 percent , all the rest answer is considered to be passed with a well scaling system, ; Very Often =100 percent, Often = 85 percent, Sometimes = 67.5 percent, Seldom = 50 percent,
- The cost of the change, which is very important in evaluation and can be performed via two stages; estimating(pricing) and controlling;
    1) Estimating change, the pricing of the change order, whether it considers indirect effects or not , this indicate whether the Company (Contractor) has a performed a well cost engineering for the CO or not. For the scoring the evaluator has two option only, yes which represent 100 percent scoring and number which represent 0 percent .
    2) Controlling the cost of the change after pricing, the company should track the cost of the change through a well based technique, which can be examined easily by knowing whether the company (contractor) has any technique used for tracking the cost of change. The scoring of this objective vary from one company to another, that was covered through the survey, the researcher give each one of the respond scale a score, despite the answer “Never” = 0 percent , all the rest answer is considered to be passed with a well scaling system,

; Very Often =100 percent, Often = 85 percent, Sometimes = 67.5 percent, Seldom = 50 percent,

- All Changes to the design documents are checked and reviewed for justifications indicates how the company (contractor) study and examine the change, in other word , the contractor evaluate the change internally. For the scoring the evaluator has two option only, yes which represent 100 percent scoring and number which represent 0 percent .

c- "*Implement Change*", Negotiation and execution of the change orders, The skill of the change order negotiator is very important, as it will indicate how the company (contractor) act and react regarding the dealing of the change orders, if the negotiator have a good skill this means that the company (contractor) will be able to deal with the change order in a professional way that reserves the contractor rights and indirectly save the project time from raising the issue to another upper level (dispute board), the skills should include the knowledge and experience in similar filed. The scoring of this objective vary from one company to another, that was covered through the survey, the researcher give each one of the respond scale a score, despite the answer "Never" = 0 percent , all the rest answer is considered to be passed with a well scaling system, ; Very Often =100 percent, Often = 85 percent, Sometimes = 67.5 percent, Seldom = 50 percent. Regarding the evaluation of the execution of the change, the evaluator has to ensure that the company (contractor) record and track the change order approval status, which indicate is very vital step in execution process. For the scoring the evaluator has two options only, yes which represent 100 percent scoring and number which represent 0 percent.

d- "*Continuously improve from the lessons learned*". The company emphasized the need to learn from the lessons of past projects executed. In order for improve, company should have a historical data base for Lessons learned which comprise any lessons learned from

scope change control, For the scoring the evaluator has two option only, yes which represent 100 percent scoring and number which represent 0 percent .

A sample of the evaluation check list is shown on Table 5.1.

5.3 Scoring

The total score is calculated for each case study, for the ease of the evaluation the researcher categorize the results in three category (A,B,C&D) as follows ;

If the score of the company between 75-100 this means the company (contractor) is categorizes under class A which means the company (contractor) is using a well-defined system and need to sustain it). If the score of the company 50-75 this means the company (contractor) is categorizes under class B which means company (Contractor) using a system but needs improvement. If the score of the company 25-50 this means the company (contractor) is categorizes under class C which means company (Contractor) using bad system and need essential involvement). Finally if score of the company less than 25 this means the company (contractor) is categorizes under class D which means company (Contractor) doesn't have a system for managing the change.

Table 5.1 Evaluation check list sample

Evaluation			
Item	Question	**Contractor**	
		Resullt	Scoring
a)	Does the company clarify the Procedure for handling change orders from the beginning of the project? yes=100, no=0		
b)	Change order is negotiated by knowledgeable persons and well studying person? yes=100, no=0		
C)	Percentage of CO initiated by Contractor to Consultant or Designer (the percentage is directly proportion to the effective control system for Change)		
d)	Percentage of the CO raised due to discrepancy between document and the site condition (the percentage is directly proportion to the effective control system for Change)		
e)	Pricing of change order considers indirect effects or not? yes=100, no=0		
f)	All Changes to design documents are checked and reviewed for justifications Very Often =100, Often = 85, Sometimes = 67.5, Seldom = 50, Never = 0		
g)	Does the company use any technique for track cost of change? Very Often =100, Often = 85, Sometimes = 67.5, Seldom = 50, Never = 0		
h)	Does the company record and track the change order approval status? yes=100, no=0		
i)	Does the company have a historical data base for Lessons learned which comprise any lessons learned from scope change control? yes=100, no=0		
Total Score			
Control System Grade (A,B,C & D)			

5.4 Results

Table 5.2 Evaluation results for the selected case studies

Evaluation								
Item	Question	**Case study number 1 (case70)**		**Case study number 2 (case23)**		**Case study number 3 (case32)**		**Case study number 4 (case 6)**	
		Result	Scoring	Result	Scoring	Result	Scoring	Result	Scoring
a)	Does the company clarify the Procedure for handling change orders from the beginning of the project? Very Often =100, Often = 85, Sometimes = 67.5, Seldom = 50, Never = 0	often	85	sometimes	67.5	seldom	50	sometimes	67.5
b)	Change order is negotiated by knowledgeable persons and well studying person? Very Often =100, Often = 85, Sometimes = 67.5, Seldom = 50, Never = 0	often	85	often	85	often	85	sometimes	67.5
C)	Percentage of CO initiated by Contractor to Consultant or Designer (the percentage is directly proportion to the effective control system for Change)	240%	85	67%	37.5	200%	85	300%	100
d)	Percentage of the CO raised due to discrepancy between document and the site condition (the percentage is directly proportion to the effective control system for Change)	67%	67	50%	50	50%	50	42%	42
e)	Pricing of change order considers indirect effects or not? yes=100, no=0	yes	100	yes	100	no	0	yes	100
f)	All Changes to design documents are checked and reviewed for justifications Very Often =100, Often = 85, Sometimes = 67.5, Seldom = 50, Never = 0	seldom	50	seldom	50	Never	0	seldom	50
g)	Does the company used any technique for track cost of change Very Often =100, Often = 85, Sometimes = 67.5, Seldom = 50, Never = 0	seldom	50	seldom	50	Never	0	seldom	50
h)	Does the company record the original document and addenda done to it via change order ? yes=100, no=0	yes	100	yes	100	yes	100	yes	100
i)	Does the company have a historical data base for Lessons learned which comprise any lessons learned from scope change control? yes=100, no=0	yes	100	yes	100	yes	100	yes	100
Total Score		80%		71%		52%		75%	
Control System Grade (A,B or C)		A		B		B-		A-	

By applying the evaluation check list we found that

1. Case study number 1 received a score 80% Class A
2. Case study number 2 received a score 71% Class B
3. Case study number 3 received a score 52% Class B^{-}
4. Case study number 4 received a score 75% Class A

From the result shown on Table 5.2, we can conclude that case number 1 and 4 are using a well-defined system and only need to be sustained. While case number 2 is considered to have a good system but needs some improvement and finally case number 3 (score 52) is considered to have almost a system but need essential improvement.

Based on the factors needed to be taken in consideration for the change order system, the improvement will be decided.

Moving deep through the results shown, analyzing the scores for each case to show the common defects are shown table 5.3.

Table 5.3 the main defected check list for selected case studies

no	Case no	Question number defect*								
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	Case study number 1 (case70)				○		●	●		
2	Case study number 2 (case23)	○		●	●			●		
3	Case study number 3 (case32)	○			○	●	●	●		
4	Case study number 4 (case 6)	○	○		●		●	●		
Common defect		●			●		●	●		

* Questions are stated in Table 5.2

○ Slightly defect (score from 51 to 67.5)

● Significant defect (score 50 and below)

● Common Defects

The scores of each question for the four case studies had been analyzed, weather it is considered to be defect or not and if this defect is considered slightly defect or significant. The table had been prepared based on the score of each question as follows; the factor will be considered defect if its score pointed 67.5 or below (from 0 to 50 it will be considered significant defect , more than 50 up to 67.5 it will be considered slightly defect).

From the results shown in table 5.3, we can noticed the most common defects that needs to be considered for the improvement of the change management process. The common defects are as follows;

1. The company is not clarifying the procedure for handling the change orders from the beginning of the project,
2. Significant discrepancy between document and the site condition,
3. All Changes to design documents are not well checked and reviewed for justifications,
4. The company is not using a well-defined technique for track cost of change.

CHAPTER SIX
CONCLUSIONS & RECOMMENDATIONS

Chapter Six

Conclusions & Recommendations

6.1 Summary

The study is treated in six chapters. Chapter one is an introduction to the study highlighting the significance of the study of change orders, the objective set for it, its scope and limitations and a brief description of the specific conditions of the construction in Egypt

Chapter two is a review of change orders in literature and it encompass a review of many articles, research studies, master and Ph.D. dissertations, as well as books written on the subject of change orders. The review is organized under seven sections: definition of change orders, types of the change orders, legislation of the change orders, different perception of the change orders, causes of change orders, impact of the change order and management aspects of change orders.

Chapter three defines the process of developing the survey questionnaire and the approach for defining the sample size, the procedures used for gathering field data.

Chapter four presents the results and findings of the study in four sections: general industry information, causes of change orders, effects of change orders, controls of change orders and testing of hypothesis on the agreement between consultants and contractors on causes, effects and controls of changes. Results on all these parameters from 70 designers, consultants, contractors and others were presented. Importance Index (II) of causes, Prevalence Index (PI) of effects, and Utilization Index (UI) of controls are tabulated. Each cause, effect, and control is ranked for designers, consultants and contractor.

Chapter five presents the evaluation of the change management control efficiency among the contractors, out of the 27 contractors only 4 were selected for evaluation. A check list is prepared and applied over the selected projects. Results were presented. The results were then analyzed to show the common defects for the selected case studies which should be considered for the system improved.

6.2 Conclusions

The causes of the change orders and their effects on the project cost and schedule are complex and influenced by numerous interrelated factors. Change management is a critical problem faced by the construction industry. It has been revealed that improving the administrative process of change orders is beneficial in reducing the cost and risk for all the project participants and encourages a more trustful relationship.

Based on the results presented in this study, the following can be concluded :

1. The general industry information collected indicates the following facts: contractors involved in large building construction are large in size and most of them reported over 10 years of experience. The common contract format in large building construction is the lump sum turnkey and the Unit price. Most changes in large building projects are electromechanical in nature. The working relation between principal parties in the construction process is generally good. Results also indicated an active participation of owners during design and construction of large buildings.
2. The only way to proceed with the change order is written approval. The verbal instruction is not accepted and if so it will be for urgent changes only and done by the employer only under specific conditions. The most common method for compensation is the Negotiated fixed price (lump sum) and the cost of the change is the most driving factor for change order.
3. The owner is the main source of changes in large building projects. Change of the owner mind is the main cause of change generated by owner. Consultant is the second major contributor to changes. The most top five important causes among all parties are lack of coordination between contractor and consultant, error and omissions in design, value engineering, change in design and change of plans by owner.
4. The average cost overrun due to change orders is shown to be between 11 and 15% of the original contract value in large building construction while the average schedule overrun is shown to be between 10 and 20% of the original project duration. The most top five effects (prevalence) of change orders are cost overrun, time overrun, disputes between parties to the

contract, quality standards enhanced and complaints of one or more of the parties to the contract.

5. The results shows that most of respondents agreed to have a clause regulating variation orders procedures as an essential feature of any construction contract. The five most certain success factors for change orders implementation are fair owner / consultant / contractor, effective change management, early detection of the change, discussion of change orders procedures / calculations and clear change order impact assessment process.
6. Having clear procedures for handling the change order from the beginning is barely found, never to consider that the change order is timely approved, it is essential for the change order negotiation to be via a knowledgeable person, never to consider scope of change order is made clear, barely the change order pricing considers the indirect effects and it is often to consider that that WBS or any other techniques is used to track the cost of changes.
7. The study first pointed out an evaluation check list that can be considered as a good indicators of whether the contractor have a good control system regarding the change management and control process. Second analyze the result of the evaluation to point out the common defects that should be considered in the improvement of the change management system.

6.3 Recommendations

Based on the findings of this research discussed in Chapter four with main conclusion listed above and the referring to findings of previous studies discussed in the literature review, the following recommendation are made:

1. As concluded earlier, the research indicates that owner is the major source of change orders in large building construction. Although the research showed that the owner gets involved during the design phase of the project, this is not enough for minimizing problems associated with changes and cost overruns. As gathered from many field interviews, the owner normally lacks the ability to read design documents prepared by the engineer. Many

interviews suggested that owners, in many instances, get surprised that what is being constructed is not what they have anticipated or envisioned. Owners of large building projects are usually businessmen who have a good level of education and with extra effort and visual aids they should be able to visualize the design. As the research showed that most changes are electromechanical, a three-dimension model is very helpful in this regard and should be used to help owners see their project before construction starts. This extra effort in understanding the design would minimize the changes made by the owner.

2. It is recommended that owners should make adequate financial planning during planning stage to avoid changing plans later or during construction.
3. It is worth noting that owners of large building projects are not repetitive owners of such projects, and their opinion will be based mostly on one project. Another justified recommendation for those owners is to get a project management consultant firm (PMC) to supervise both the design and construction activities to insure that the owners' needs and expectations are met by the design. The practice of appointing PMC is rarely adopted currently.
4. The research showed that change orders are thought of as additional revenue for the contractor. It is recommended that contractors educate their personnel on the negative effects of change orders. As concluded in the review of literature earlier, changes should prove a very high benefit to cost ratio to be considered feasible. Contractors should consider direct and indirect impact of changes for their evaluation to be complete.
5. The research showed that freezing of design is among the least used control against change orders. Owners should consider using this control more often to avoid the problem of creeping scope where the control over scope is lost. This condition definitely accelerates rate of changes generated in the project.
6. Contractors should consider using a Work Breakdown Structure or other tracking system more often than is used now. Many contractors indicate they are not using any type of structuring system for their construction activities and this may lead to an inability to trace the effects of change orders on the rest of the project.

7. For the change management system improvement. The contractor should clarify the procedure for handling the change orders from the beginning of the project, perform well check and review for all the changes with the contract documents and apply a well-defined technique for tracking the cost of the change.

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Appendix (A)

List of Respondents

no	Respondent personal information			Company information		
	name	position	years of experience	Company name	Company type	company years of experience
1	Nabil Abd El baset	Resident Engineer	>20 years	EHAF Consulting Engineers	Consultant	>20 years
2	Mohamed Nour	Project Manager	>20 years	The Arab Contractors Osman A. Osman	Contractor	>20 years
3	Amr Kamel	Project Manager	>20 years	Orascom Consrtuction International	Contractor	>20 years
4	Mohamed Handousa	Scheduling Manager	10-20 years	Projacs	Others	>20 years
5	Mohamed Badr	Project Manager	>20 years	Turner	Others	>20 years
6	Dr Amr Bakry	Project Manager	10-20 years	Samcrete Egypt	Contractor	>20 years
7	Mohamed Kashef	Project Manager	10-20 years	Engineering Consulting Group - ECG	Consultant	>20 years
8	Dr Nancy Nagy	Project Manager	10-20 years	Dar el Handasa	Designer	>20 years
9	Mohamed Nour	Project Manager	>20 years	Allam Sons	Contractor	>20 years
10	Mahmoud Gabr	Project Manager	>20 years	Shaker Group	Consultant	>20 years
11	Mohamed Ali Shawky	Project Manager	>20 years	AAW Consulting Engineers	Consultant	>20 years
12	Alaa Mazhar	Project Manager	>20 years	The Arabian Construction Contractor	Contractor	>20 years
13	Tarek Kabil	Project Manager	>20 years	Siemens	Contractor	>20 years
14	Adel Tork	Project Manager	>20 years	Hamza Associates	Consultant	>20 years
15	Medhat Fikry	Project Manager	10-20 years	Livingin Design house	Designer	10-20 years
16	waleed Nabil	Project Manager	10-20 years	ECO-Dr Ali Abd el Rahman	Consultant	>20 years
17	Ahmed KAmel	Project Manager	>20 years	Dar el Memar for contracting	Contractor	10-20 years
18	Mohamed Alaa el din	Scheduling Manager	10-20 years	Arab Bureau for design & technical consulting	Designer	>20 years
19	Magdy Abd el wahab	Construction Manager	10-20 years	MEMAAR Company for Engineering & Contracting	Consultant	10-20 years
20	Wael galal	Quality Manager	10-20 years	Dr Amr El gohary office	Designer	>20 years

21	Adel mohamed	Resident Engineer	10-20 years	Bureau Veritas - egypt office	Consultant	>20 years
22	Samir Habashi	Project Manager	10-20 years	Al Habashi General Contracting	Contractor	>20 years
23	Moustafa Mohamed	Quality Manager	10-20 years	Mivan	Contractor	>20 years
24	Mohamed ragab	Project Manager	10-20 years	Dr.Mohamed Ragab office	Designer	10-20 years
25	Albeer Emil	Resident Engineer	10-20 years	Hyundai engineering and construction	Contractor	>20 years
26	Mahmoud El khatib	Project Manager	>20 years	the egyptian german group for consulting eng.	Consultant	10-20 years
27	Hisham mourad	Project Manager	>20 years	MAHAM	Others	10-20 years
28	Mohamed Aboud	Construction Manager	10-20 years	Lotus	Designer	10-20 years
29	Mohamed Mahmoud	Scheduling Manager	10-20 years	AL Shafar General Contracting - ASGC-Egypt office	Contractor	10-20 years
30	Amr Okeil	Quality Manager	10-20 years	Lamasat	Designer	5-10 years
31	Sady El zouheiry	Scheduling Manager	10-20 years	Tiba - contracting and real state	Contractor	>20 years
32	Thoria Helmy	Construction Manager	10-20 years	Dr Abd el halim office	Consultant	>20 years
33	Salah Eldin el hosieny	Cost Manager	>20 years	El Nasr Building and Construction Egypt	Contractor	>20 years
34	Mohamed Shibl	Construction Manager	10-20 years	SIAC	Contractor	>20 years
35	Osama Fawzy	Project Manager	>20 years	Dorra Group	Consultant	>20 years
36	Hazem Hosieny	Scheduling Manager	10-20 years	Masharee for Project Management	Others	10-20 years
37	George Fikry	Project Manager	10-20 years	Roaya	Designer	10-20 years
38	Mohamed Farouk	Project Manager	10-20 years	Al-Bonian	Consultant	10-20 years
39	Mohamed Anwar	Project Manager	>20 years	Detac	Contractor	10-20 years
40	Hesham Samy	Construction Manager	>20 years	United Engineering	Consultant	10-20 years
41	Mohamed Abo El enien	Project Manager	10-20 years	CEG Contracting and Agencies	Contractor	10-20 years
42	Ehab El Ansary	Project Manager	>20 years	The Pharonic group for consultancy engineering	Consultant	10-20 years
43	Mohamed Fathallah	Project Manager	10-20 years	EMCO Contracting Egypt	Contractor	10-20 years
44	Ehab shehata	Construction Manager	>20 years	Concept	Designer	10-20 years
45	Ashraf Kasab	Project Manager	>20 years	Delta Egypt Construction	Contractor	>20 years
46	Tamer Abo Bakr	Construction Manager	10-20 years	Integrated Consultancy Group	Consultant	10-20 years
47	Wafaa Ali	Project Manager	>20 years	Consolidated Contractors Company-CCC	Contractor	>20 years

48	Alyaa Younes	Project Manager	10-20 years	Shehab Mazhar Architects	Designer	>20 years
49	Ayman Tohamy	Project Manager	10-20 years	Matrix	Consultant	10-20 years
50	Mohamed Samir	Quality Manager	10-20 years	Farouk Al Gohary Office	Designer	>20 years
51	Haytham Safii	Construction Manager	10-20 years	El Nemr General Contracting Group	Contractor	>20 years
52	Ibrahim Gouda	Project Manager	>20 years	Gouda consultant service	Consultant	10-20 years
53	Nehad Kamal	Project Manager	10-20 years	EMEND	Others	10-20 years
54	Adel mohamed	Project Manager	>20 years	Osman Group	Contractor	>20 years
55	Moustafa El Kady	Quality Manager	10-20 years	Dr.Farouk El Kady	Designer	>20 years
56	Mohamed Talaat	Construction Manager	>20 years	National Company for General Contracting	Contractor	>20 years
57	Ahmed Emam	Project Manager	10-20 years	E+K Architecture	Designer	5-10 years
58	Waleed Moustafa	Construction Manager	10-20 years	Global Consultant Engineers	Consultant	10-20 years
59	Ahmed shoukry	Cost Manager	10-20 years	Diar AlTamer Company	Contractor	10-20 years
60	Mohamed shourbagy	Quality Manager	10-20 years	Sabbour Engineering Consulting	Consultant	>20 years
61	Mohamed Oukda	Construction Manager	10-20 years	Alexandria Construction Co -	Contractor	>20 years
62	Khaled Shalaby	Resident Engineer	10-20 years	Dar El Qahira	Consultant	>20 years
63	khaled Adly	Cost Manager	10-20 years	EGYDAN	Others	10-20 years
64	Islam Mohamed	Scheduling Manager	10-20 years	Abo EL Hanna ikhwan for general Contracting	Contractor	>20 years
65	Ahmed Kabish	Project Manager	10-20 years	Beyout	Designer	<5 years
66	Maged Shoukry	Project Manager	>20 years	APM	Consultant	10-20 years
67	Khaled Ghanim	Project Manager	10-20 years	Living In	Contractor	10-20 years
68	Khaled Rakha	Cost Manager	>20 years	Pechtel	Others	>20 years
69	Sherif el Abd	Project Manager	>20 years	logic	Designer	10-20 years
70	Atef Ewida	Cost Manager	>20 years	Besix	Contractor	>20 years

Appendix (B)

Detail List of Selected Projects for Evaluation

no	Project name	Project Type	Project size	Variation Percentage	Extended Time percent
70	Cairo Fairmount Hotel	Commercial	100-250 Million	11-15 %	21-50%
23	Cairo Festival City _ Zone B villas	Residential	100-250 Million	16-20%	21-50%
32	Comfort Factory	Industrial	50 Million	0-5%	21-50%
6	The New AUC Campus	Institutional	250-500 Million	0-5%	21-50%

Appendix (C)

Questionnaire Sample

The Arab Academy for Science & Technology & Maritime Transport	College of Engineering and Technology Construction and Building Engineering Department **Questionnaire form**	used for research only Day _____ Month _____ Year ____2011___ Form no.

A.Respondent / Organization Data		
Name		Position
Telephone No.	Years of Experience	e-mail
Your company name is		
Company type □ Contractor □ Consultant □ Other, specify _ _ _ _ _ _ _ _ _ _ _ _ _ _		
How many years of experience does your company have in large building projects ?		
□ Less than 5 years □ 5-10 years □10-15 years □ Over 15 years		

B. Data
B.1 General data : (the following questions will be answered based on your project data)
1. what is the project type ?
□ Residential □ Commercial □ Industrial □ Institutional □ Infrastructure □ Military
2. What type of construction is this project
□ Addition/Expansion □ New □ Rennovation
3. What is the project size (EGP)?
□ < 50 Million □ 50-100 Million □ 100-250 Million □ 250-500 Million □ >500 Million
4. What is the type of the Owner ?
□ Private □ Public □ Others,Specify _ _ _ _ _ _ _ _ _ _ _ _
5. What is the contract type ?
□ Lump sum □ Unit Price □ Cost plus
□ Turnkey □ Granted Maximum price □ Others, specify _ _ _ _ _ _ _ _ _ _ _ _
B.2 Change Order data :
(the following questions will be answered based on your project data)
1. Number of the change orders initiated by the Owner _ _ _ _ _ .
2. Number of the change orders initiated by Contractor _ _ _ _ _ .
3. Number of the change orders initiated by Consultant _ _ _ _ _ .
4. Compensation for change orders are based on :
□ Unit prices as stated in the bid □ Adjusted unit prices □ Actual cost plus a margin
□ Negotiated fixed price □ Others, Specify _
5. What type of changes are authorized to proceed without formal (written) approval?
□ None □ Under certain price limit □ Urgent changes □ Others, specify_ _ _ _ _ _ _ _ _ _
6.How many approvals are required for change orders in your company?
□ One □ Two □Three □ More than three

7.The working relation between principal parties is normally

□ Excellent □ Very good □ Good □ Fair □ Poor

8.The primary driving factor in large building projects is

□ Cost □Schedule □Quality

9. Which craft generate more change orders in large building projects?

□Electrical □Mechanical □Civil □ Structural □ Finishes

B.3 Causes Leading to Change Order (From your experience)

1.Check the most top five causes of variations among all contractors and consultants are as follows

□ Change of planes by owner □ Owner financial difficulties

□ Owner change of schedule □ ill –defined project objective

□ Substitution of material or procedures □ Change in design

□ Conflict between contract and document □ Lack of coordination

□ The scope of work for the contractor is ill-defined.

□ Contractor desire to improve his financial conditions

□ Error and omissions in design □ Value engineering

□ Contractor financial difficulties □ Differing site conditions

□ Unavailability of skills □ Unavailability of equipment

□ New government regulations □ Defective workmanship

□ Safety consideration □ Weather condition

□ Technology change

2. Check The level of owner involvement is expressed in terms the stages he get involved in the process of design and construction of the project ;

□ The owner gets involved in both design and construction stages,

□ The owner gets involved in the design stage only,

□ The owner gets involved in the construction stage only.

□ Does not involve

3. Check the most frequently involved origin-agents in the generation of variation orders;

□ The Owner

□ The Designer or the Consultant,

□ The Contractor.

4.a. If your answer in question 3 is the Owner, rank the following causes in ascending order

Cause/Reason	Clarification	Rank
Change of mind	Clients change their minds or requirements	
Unclear brief	Clients do not clearly state what they need then request for changes during the construction stage. Client clip is inevitable in the current market conditions	
Client satisfaction	Clients pursue to achieve their dream as they wish. Since the projects ultimately belongs to them, even when they do not know what they wants, they are always right	
Budget constraints	Budget constraints or the clients seek to make some savings	
Others	Please specify _ _ _ _ _ _ _ _ _ _ _ _ _ _	

4.b. If your answer in question 3 is the Consultant, rank the following causes in ascending order

Cause/Reason	Clarification	Rank
Corrections	A consultant usually issues instructions to correct a poor design	
Lack of understanding	The lack of understanding of the requirements of the client by the consultant leads to variation orders	
Communication	Lack of communication and coordination between the consultant team may lead to variation orders	
Unforeseen	A consultant initiates a variation order due to unforeseen details at tender phase	
Others	Please specify _ _ _ _ _ _ _ _ _ _ _ _ _	

4.c. If your answer in question 3 is the Contractor, rank the following causes in ascending order

Cause/Reason	Clarification	Rank
Forecast	The contractor may be aware of the potential change and requests for instruction.	
Procurement approach	Contractor hardly contributes to variation orders as they carries out works according to the design and has number influence on design changes	
Construction methods	Request by the contractor for alternative material/method for construction	
Remedial works	Variation orders issued for corrective or remedial works following a faulty of the contractor	
Others	Please specify _ _ _ _ _ _ _ _ _ _ _ _ _	

B.4 Impact of Changes

The following are possible consequences or effects of change orders in large building construction

From your project data indicate how often you face these effects.

1.What is the average cost of the change orders as a % of the original contract value ?

☐ Below 0 % (saving) ☐ 0-5 % ☐ 6-10 %

☐ 11-15 % ☐ 16- 20 % ☐ Above 20 %

2.What is the increase in completion schedule because of change orders as a % from planned one ?

☐ < 10 % ☐ 10-20 %

☐ 21-50 % ☐ > 50 %

3.Check and Rank the most top five prevalent impact of variations out of the following :

Impact	Check	Rank
Cost overrun (increase in project cost)	☐	
Time overrun (Delay in completion schedule)	☐	
Disputes between parties to the contract	☐	
Additional specialist equipment/personnel	☐	
Complaints of one or more of the parties to the contract	☐	
Quality standards enhanced	☐	
Professional reputation of one or more parties adversely affected	☐	
Additional health and safety equipment/measure	☐	
Degradation of quality standards	☐	

C. Control/Manage Change Orders

C 1.The following questions based on your your experience

1.Do you agreed that a clause permitting variation orders was an essential feature of any construction contract ?

☐ Yes ☐ Number

2.Check and rank the five most certain success factors for change orders implementation according to their order of importance:

	Success Factors	Check	Rank
	Well-defined change order scope	□	
	Fair Owner/Consultant/Contractor.	□	
	Non-confrontational environment.	□	
	Expedient decision-making.	□	
	Early detection of the change.	□	
	Discussion of change orders procedure I calculations	□	
	Complete engineering in original contract.	□	
	Effective change management I control process.	□	
	Clear change order impact assessment process.	□	
	Existence of dispute resolution process.	□	
	Overhead profit and markups based on sliding or relative scale.	□	
	Incorporation of computer in the change order process to facilitate data storage	□	

C2. based on the project data

1. Do your company have a well defined system for Change order process?

☐ Yes ☐ Number

2. The Procedure for handling change orders is clear from the beginning

☐Very often ☐Often ☐Sometimes ☐ Seldom ☐ Never

3. The Change order approval is timely

☐Very often ☐Often ☐Sometimes ☐ Seldom ☐ Never

4. The Change order is negotiated by knowledgable persons

☐Very often ☐Often ☐Sometimes ☐ Seldom ☐ Never

5. The Scope of change order is made clear

☐Very often ☐Often ☐Sometimes ☐ Seldom ☐ Never

6. The Pricing of change order considers indirect effects also

☐Very often ☐Often ☐Sometimes ☐ Seldom ☐ Never

7. All Changes to design documents are checked and reviewed for justifications

☐Very often ☐Often ☐Sometimes ☐ Seldom ☐ Never

8. WBS or other technique is used to track cost of changes

☐Very often ☐Often ☐Sometimes ☐ Seldom ☐ Never

Thank you for completing the questionnaire.

Fig3.2 Questionnaire sample

ARABIC SUMMARY

الخلاصة

يستهدف هذا البحث الى توفير نظرة أعمق و أدق الى أوامر التغيير فى مشاريع الانشاءات و البناء الكبرى فى جمهورية مصر العربية و ذلك للوصول الى أفضل الطرق الادارية للحد و التخفيف من تأثيرات أوامر التغيير اثناء تنفيذ المشرايع الإنشائية . و قد قام الباحث لإنجاز هذا الهدف بدراسة أوامر التغيير فى النشرات و الدوريات و الكتب المتخصصة لتحديد أنواع التغيير و أهم الأسباب التى تؤدى الى التغيير، اثر التغيير فى المشاريع و الطرق الإدارية المتبعة لإدارة أوامر التغيير و من ثم تحديد أنسب الطرق لإدارة أوامر التغيير و التى ساهمت فى تقييم كفاءة عملية إدارة التغيير بالنسبة لمقاوليين .

تم تقسيم الدراسة الى ثلاثة أجزاء ، الجزء الأول يشمل استعراض موضوع أوامر التغيير من المراجع السابقة و تشمل الدراسات، الدوريات، النشرات، تقارير البحوث و بعض الكتب المتخصصة فى المجال . تم إستخدام المعلومات و خلاصة التوصيات فى هذا الجزء كمقدمة لتطوير و انشاء نموذج الإستبيان حول الموضوع بين مقاولى، مهندسى، استشارى و مديروا لمشاريع فى المشروعات الكبرى.

الجزء الثانى و هو مسح ميدانى، تم توزيع استبانة أكثر من 70 خبير من ذوى الخبرة المنتمين لكبرى الشركات العاملة فى مجال الانشاءات (تصميم، إشراف، مقاولات، ادارة مشروعات)، احتوت الإستبانة على أسئلة تدور على أربعة محاور. المحور الأول معلومات عامة وأولية عن الخبير، الشركة والمشروع. المحور الثانى حول أسباب اوامر التغيير. المحور الثالث حول الاثار و النتائج المترتبة على اوامر التغيير و المحور الأخير حول الطرق و الوسائل المتبعة لإدارة و متابعة اوامر التغيير. تم تجميع و تحليل و عرض النتائج بطريقة مبسطة عن طريق حزمة من الاحصائيات استخدام الحاسب الألى.

الجزء الثالث و الأخير , هو تقييم كفاءة عملية أوامر التغيير لعينات مختارة من المقاوليين المشاركين فى الإستبيان و مدى كفاءتها و كذا غبراز نقاط الضعف حتى يتم التركيز عليها لتحسين الأداء. تم ذلك من خلال تطبيق نموذج التقييم الذى تم إعدادة على اسس و معايير مناسبة