Faculty of Business
MSc in Project Management

MSc Dissertation

Variation Order (Change Order) in Oil & Gas Projects

By
Ahmed Salem Al Hammadi
20040029

ABSTRACT

This thesis presents result of a study on causes and effects of variation order (change order) in Oil & Gas projects in the UAE. To achieve the study objective the researcher carried a literature review of the subject covering periodicals, dissertations, previous research studies and books written on the subject of variation orders (change orders). In light of the literature study the researcher developed survey questionnaires.

The questionnaire was designed to meet the research aims and objectives and to test its hypothesis. The aim of the questionnaire is to identify the most important causes of variation order in oil and Gas projects; however, it was also valuable to examine the ground that may cause these variations, including procurement methods and tendering arrangements. In addition, it was expected that the respondents' knowledge and experience would differ from one to another, and that this might have an impact on their answers, so attention was paid to addressing this point. A list of such ideas was considered in constructing the questionnaire

In order to present the questionnaire in a systematic way, it was decided to divide the questions into four sections:

Section One – questions concerned with person experience. This contains general questions about the profession, period of experience, sector and size of projects.

Section Two – questions dealing with contractual arrangement, including procurement methods and tendering arrangement.

Section Three – questions dealing with performance of the projects that the person has been involved in. This section identifies the number of projects that the person has participated in and then and then asks how many of them were varied and what the average variation in term of cost. It also has a question about the average variation that was authorized by client, the party responsible for the variation and five most important causes of variation.

Section Four – this section includes the list of 67 causes of variation order in Oil and Gas Projects. Four scales were identified to calculate the frequency and occurrence and the degree of severity of each cause.

Responses from 43 clients, consultants and contracts working in the field of oil & gas projects were analysed. Analysis of data indicated that the cost overruns due to variation orders (change orders) were less that 10% of the original contract value.

The study also concludes that the project management consultant (PMC) and client make an integrated team with the client in order to review the design as one team to understand the design and to ensure owner's needs and expectations.

DEDICATION

To my Parents, the first to teach me

To my wife for care and support

And to my children, Mohamed and Ayesha with hope for a bright future

ACKNOWLEDGEMENTS

I wish to express my deep appreciation to Professor Ashly Pinnington for his support and guidance.

I would like to express my thanks to all members of oil & gas projects for their positive participation that provided me with the necessary data.

My thanks and grateful is due to my wife for her support and patience.

Table of Contents

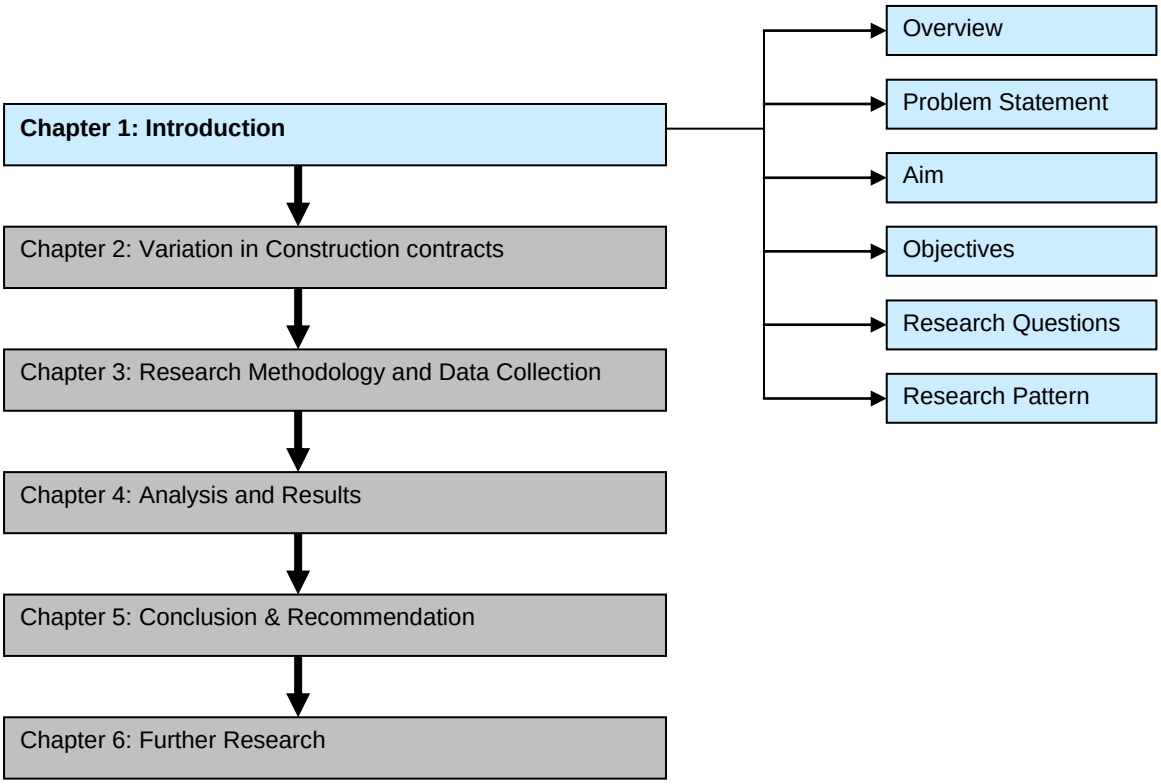
List of Figures

List of Tables

Chapter1

1 Introduction

This chapter introduces the research on the effect of variation order on Oil and Gas projects. It provides an overview of the region; demonstrates the importance of the research to the construction industry; and documents the aim and objectives of the research undertaken along with research questions.



1.1 Overview

The United Arab Emirates (UAE) is a federation of seven states located in Arabian Peninsula formed in 1971 by the then Trucial States after gaining independence from Britain. The UAE comprises of seven Emirates which are: Abu Dhabi (Capital), Dubai, Ajman, Fujairah, Ras-al-Khaimah, Sharjah and Umm-al-Quwain. Each emirate maintains a large degree of independence and the UAE is governed by a Supreme Council of Rulers made up of the seven Emirs, who appoint the Prime Minister and the Cabinet.

The emirates are Abu Dhabi, Dubai, Ajman, Fujayrah, Ra's al-Khayma, Sharjah and Umm al-Qaywayn. The states maintain a high level of autonomy.

The president of the federation and ruler of Abu Dhabi is H.H. Shaikh Khalifa bin Zayed bin-Sultan Al Nuhayyan, who is re-elected every five years. The vice president and prime minister is the president of Dubai, H.H. Shaikh Mohamed bin-Rashid Al-Maktoum.

There is a large economic imbalance between Adu Dhabi and Dubai, and the five poorer northern emirates. Important domestic issues for the emirates are the development of these five and the heavy reliance on expatriate labour. In foreign affairs, the UAE has a longstanding territorial dispute with Iran over three Gulf islands, Abu Moussa, Lesser Tunbs and Greater Tunbs, which Iran has occupied since 1971 but there are signs of a thaw in relations (Source: Meed).

Full Name:	**United Arab Emirates**
Capital:	Abu Dhabi
Area:	83,600 sq km
Population:	4,444,011 (July 2007 est.)
Head of state:	President Khalifa bin Zayid al-Nuhayyan
Currency:	Emirati dirham (AED)
Religions:	Muslim 96% (Shi'a 16%), other (includes Christian, Hindu) 4%
Languages:	Arabic (official), Persian, English, Hindi, Urdu
International organizations:	Arab League, GCC, Maghreb Arab Union, OPEC, IAEA, IMF, UN, WTO

Table 1: UAE at a glance **(Source: Meed)**

Economy

Abu Dhabi accounts for 90 per cent of the UAE's oil and gas production, having more than 90,000 million barrels of recoverable crude and the world's fifth largest deposits of natural gas. It has been the lead contributor to the federal budget and has helped with development projects in the other emirates.

The UAE economy is heavily dependent on oil therefore and on foreign labour, especially in the private sector where 96 per cent are expatriates. An Emiratisation programme is in progress, which has been successful in some sectors. In the oil and gas sector, Abu Dhabi National Oil Company (ADNOC) is planning a large investment in engineering, procurement and construction (EPC) and plans to raise its sustainable oil capacity and upgrade its hydrocarbon infrastructure.

The government is keen to increase private sector involvement in the economy. Abu Dhabi is the leader in attempts to attract private capital into its infrastructure sector, and has a target of having private sector involvement in all its power generators. Several independent water and power projects (IWPPs) have already been successfully implemented (Source: Meed). Without any major hydrocarbon reserves, the five northern emirates have traditionally been dependent on the federal government, and by extension Abu Dhabi, for upgrading their infrastructure. However they are trying to increase private sector involvement. The Gulf's first privately funded wastewater network is to be constructed in Ajman, and the governments of Ajman and Sharjah have signed a production sharing agreement on the development of the offshore Zora gas field.

	2005	2006	2007 (forecast)
GDP (at current prices)	112,429	163,000	-
Non-oil GDP as % of GDP	-	-	-
Population (millions)	4.9	4.5	-
Population growth (%)	7.0	9.7	-
GDP per capita ($)	22,643	36,222	-
Real GDP growth (%)	10.0	8.9	5.8
Nominal GDP growth (%)	17.0	23.4	24.0
Inflation (%)	4.7	13.8	-
Unemployment (%)	-	-	-
Trade			
Imports	53,100	71,115	-
Exports	81,100	115,437	-
Trade balance	28,000	44,324	-
Budget			
Surplus/ deficit	855	Na	-
Surplus/ deficit as % of GDP	0.8	Na	-
Debt			
External debt	15,300	43,188	-
External debt as % of GDP	18.0	24.4	-
Sovereign ratings			
CI	A+	AA-	-
S&P	Nr	Nr	-
Moody's	Aa3	Aa3	-
Fitch	Nr	Nr	-

Table2: Economic indicators (Source: MEED) ($ million, unless stated)

1.2 Problem Statement

In order to increase oil production and to sustain current oil production there are large number of Oil & Gas Projects going on and there is limited academic research in the field of Variation Order (change order) in this industry. Thus it is important to explore variation order (Change Order) in the Oil & Gas Projects and understand their influences.

1.3 Aim of the research

Enhancing the performance of project management in Oil & Gas through the effective management of variations.

1.4 Objectives

- Identify the main causes of variations on Oil & Gas Project.
- Identify the underlying reasons for changes within Oil & Gas projects.
- Examine the effectiveness of current practice in the management of change.
- Investigate the potential effects of variations on Oil & Gas's operations.
- Identify strategies to reduce the level of variations

1.5 Research Questions

The objectives of the research are formulated in the form of research questions to make research process easier and these questions are:

1. What are the underlying reasons for changes within Oil and Gas projects?
2. To what extent is the overall budget affected by cost and time variation?
3. How will operational activities be affected by variations?
4. What are the current practices in the management of variations and how they can be made more effective?

1.6 Structure and Contents of the Research

The dissertation comprises of six chapters, which seek to address the defined objectives of the research. The six chapters are as follows:

Chapter 1- Introduction: The introductory chapter presents the foundations of the study by providing an overview about the UAE, the emirate of Abu Dhabi. The research is focused by developing its aim and objectives. The aim of the research is enhancing the performance of project management in Oil & Gas through the effective management of variations. The objectives of the research are then translated into research questions.

Chapter 2- Variation in Construction Contracts: This chapter is a literature review of prevailing theories related to management of variation. The chapter explores the subject of variation order by defining the term variation, analyzing the underlying reasons for variations and identifies the time and cost impact on the overall budget and plans. The chapter further investigates the existing literature related to the current practice in the management of variations.

Chapter 3 – Research Design and Methodology: The chapter considers some of the available research approaches and describes the method adopted to achieve the specified set of objectives. Research questions have been developed based on the research objectives and the literature reviewed. On the basis of these a questionnaire was developed.

Chapter 4 – Analysis and Results*:* This chapter analyzes the results from the questionnaire distributed to professionals working in the Oil and Gas industry. The five research questions are discussed in the light of the literature review and the data collection results. Also it reviews the extent that these results contribute to validating the findings and conclusions of previous studies.

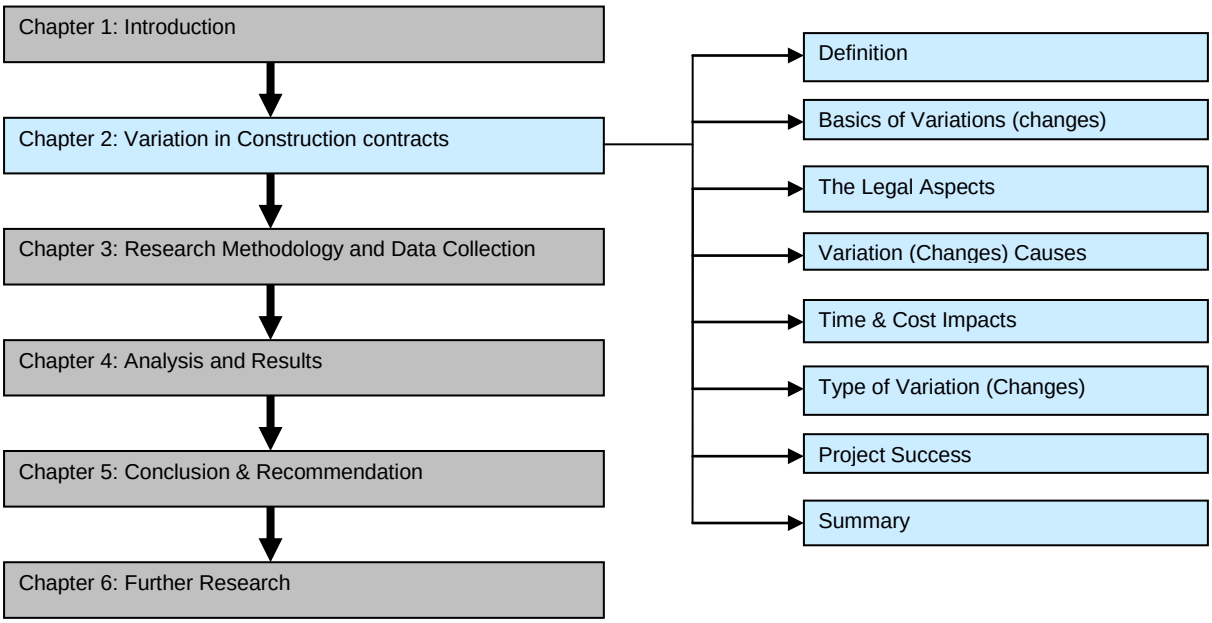
Chapter 5 – Conclusions and Recommendations: This chapter presents the conclusions in the form of answering the research questions posed in the first chapter. The five research questions are answered in the light of literature review in number of places and the survey results also validates the earlier studies.

Chapter 6- Future Research: The findings of the research provide a platform for further studies in the area of Variation order in Oil and Gas Projects.

Chapter 2

2 Variation in Construction Contracts

In Chapter 1, we discuss the aims and objectives of this research and describe the structure of this dissertation. In this chapter, we will undertake a literature review to understand and define "a variation" in Section 1. In Section 2 we will identify the various kinds of variations occurring in construction contracts and possible causes of such variations in the available literature.



2.1 Definition

Notwithstanding the most advanced tools and techniques available for project management, variations have come to be considered as an expected occurrence in any project. Accordingly significant work has been done by researchers to define, analyze and recommend appropriate solutions to manage variations in different project environments.

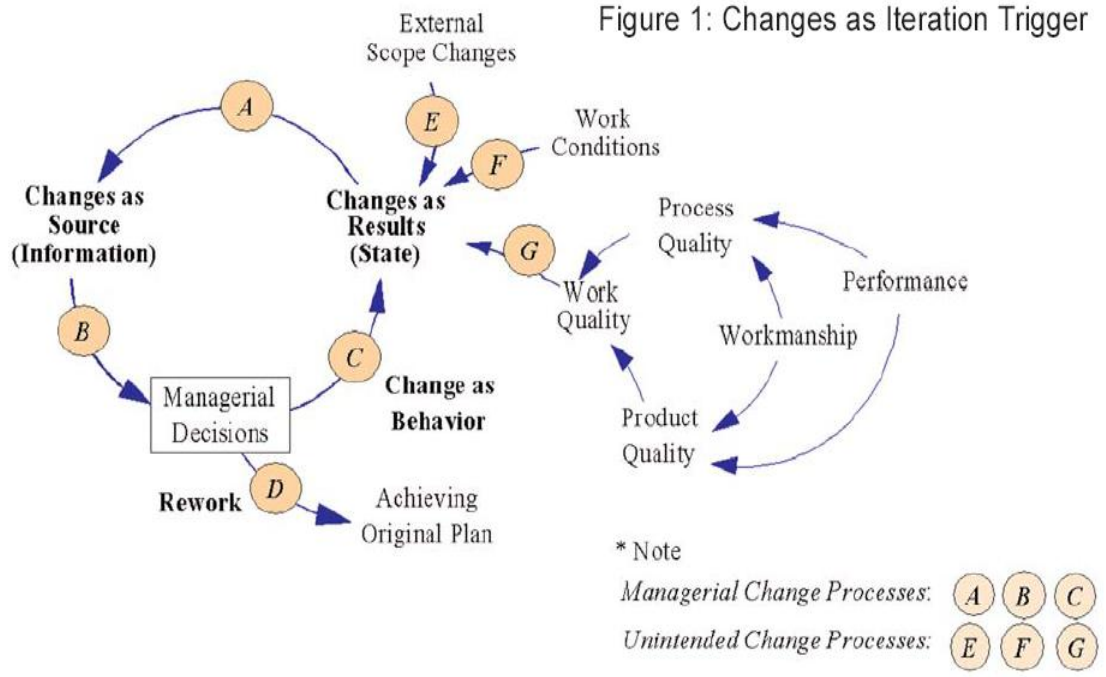
Variations have been defined in different ways by different researchers. The Association of Project Management describes variation in very simple terms as "A change in scope or timing of work which a supplier is obliged to do under a contract" (APMP Syllabus, 2000). However, a more detailed definition is provided by John Molloy (1999) as 'any alternation of the work whether by way of addition, modification or omission to the work to be done under the contract by the contractor. Such changes may cover but are not limited to the work required but excluded from the contract, work not required but included in the contract, additional work requested by the client, changes to the written scope requested by the client, changes to the character or quality of materials or construction methods and changes applicable to site conditions, location, etc'.

A different type of definition is provided by Harrell Remodeling Inc (HR) which refers to the actual work measured after project completion and may turn out to be more or less than the estimated value included in the tender. Such changes are managed by using a change order or variation.

Another definition of variation is presented by Moonseo Park (2003) who defines construction changes as referring to 'work state, processes, or methods that deviate from the original construction plan or specification. They usually result from work quality, work conditions or scope changes. Meanwhile, the changes that have been already made (denoted as Changes as Result in Figure 1)' can be the source of subsequent changes in other tasks (denoted as Changes as Source in Figure 1). For example, changes in the design work that have been made by mistake can cause subsequent changes in the construction process. 'In this case, the design changes are a result to the designer, while to the construction crew they are a source of subsequent changes. In addition, the need for changes can be also seen as an action of making a change (denoted as Change as Behavior in Figure 1), which is further categorized into 'unintended change' and 'managerial change'. Unintended changes occur

without the intervention of managerial actions. The arrows labeled *E*, *F*, and *G* in Figure 1 illustrate the unintended change process. Meanwhile, managerial changes are made by managerial decisions during quality management or project monitoring and control. As illustrated in Figure 1, once changes occur during construction (*A* and *B*), changes result in either subsequent changes (*C*) or rework (*D*), depending on managerial decisions.'(moonseo Park, 2003)

Figure 1: Changes as Iteration Trigger



(Source: Moonseo Park, 2003)

'Any additions, deletions, or other revision to project goals and scope are considered to be changes, whether they increase or decrease the project cost or schedule. Most commonly, lack of timely and effective communication, lack of integration, uncertainty, a changing environment, and increasing project complexity are the drivers of project change (Naoum 1994). In addition, these changes may affect other aspects of the performing organization that may have program management implications'
(Source: http://faculty.kfupm.edu.sa/CEM/assaf/Students_Reports/Change-Orders-in-construction.doc).

'A variation is any deviation from an agreed well-defined scope and schedule. Stated differently, this is a change in any modification to the contractual guidance provided to the contractor by the owner or owner's representative. This includes changes to plans,

specifications or any other contract documents. A variation order is the formal document that is used to modify the original contractual agreement and becomes part of a project's documents (Fisk, 1997; O'Brien, 1998)' *(Facilities, 2006, 23(11)).*

Furthermore, a variation order is a written order to the contractor signed by the owner and issued after execution of the contract, authorizing a change in the work or an adjustment in the contract sum or the contract time (Clough and Sears, 1994). Change orders can be grouped into three categories: unforeseen conditions, design issues and changes in scope.

1. Unforeseen conditions include such things as rock or unsuitable soils encountered during excavation, or surprises uncovered during the renovation of an existing facility. This category also includes change orders that involve time delays due to unexpected severe weather or changes in the building codes enacted after a project starts.

2. Design-related change orders can be more complicated than a simple human error. Interpretation of the building codes, accommodating changes from equipment manufacturers or utility companies, or modifying details to better suit field conditions all can result in change orders.

3. Changes in scope make up the third category. For example, most hotel owners don't dispute the fact that if they add something to a project, a corresponding change order will be generated. Unfortunately, not all scope changes gain the full consensus of the owner. Sometimes, the scope change relates to something that the owner "thought" he told the designer. Or perhaps the owner thought the builder "should have" anticipated expectations for a certain detail. Problems also arise when there are multiple individuals involved on behalf of a hotel owner, and each one adds input during the construction project.

Changes in scope requested by a hotel franchisor can also add significant cost, depending on how far along the construction has progressed. To avoid last-minute changes, hotel owners should verify with the franchisor during the buying process which version of prototype drawings is required and how soon the next version will be released (Based on: Michel Gibeault, AIA, March 2007).

2.2 Basics of Variations (Changes)

Variation or Change Orders occur when there is a change in the agreed terms and conditions, scope of work, bills of quantities, and technical specs, etc issued with the contract. While changes may be initiated by any stakeholder of the contract (contractor, consultant, owner, etc), all changes must be approved by the owner.

The initiation of change orders can be summarized to occur principally due to the owner (generally scope change), engineer (arising from site conditions, new regulations, etc), project management firms or contractor (design error, value engg., field requirements, etc) (CII publication 6-10 (1990)).

Changes/variations can be most commonly classified broadly into three types:

- **Based on cause/originator:** arising from design, construction, fabrication, transportation or operability (Burati, Farrington and Ledbetter 1992; Thomas and Napolitan 1994). Design changes, which constitute the major cause (52.2%), can be further sub-classified into design changes caused by improvements, by owner, and due to errors and omissions. The owner's change of mind is the biggest cause of change in residential projects (Burati et al., 1992).
- **Based on net effect on scope**: This subdivided into additive (addition of works); deductive (deletion of works); rework (due to poor quality) and force majeure (CII Publication 6-10 (1990), Fisk 1988).
- **Based on the procedure used to implement changes: F**ocused on the legal aspects of the change such as: Formal/Directed Change; Construction Change; Cardinal Change (CII publication 6-1-1990; Fisk 1988; Cox 1997).

2.3 The legal aspect

In this regard, we refer to literature discussing legal aspects such as contract changes, clause interpretation, substantiation and management of claim. The major legal aspects are:

- Selecting the best delivery system (contract format)
- Drafting and interpreting change clauses
- Documenting change order to be ready in case of litigation.

Majority of the available literature deals with the review of claims after they have taken place but the owner's management of change orders must anticipate such issue resolutions from the outset (Ashly and Workman, 1986).

Construction contracts generally comprise of:

- Bid form
- Agreement form
- General condition or standard specifications
- Special provisions
- Plans
- Addenda

(Ashly and Workman, 1986)

Generally, contracts are classified based on the method of compensation as Fixed Price and Cost Reimbursable. 90% of the contracts in construction are of fixed price type (Ibbs et al., 1986). Fixed type contracts ensure competitive prices for the owners but quality suffers, while Cost Reimbursable contracts ensure better quality of works (based on: http://faculty.kfupm.edu.as/CEM/assaf/Students_Reports/Change-Orders-in-Construction.pdf).

2.3.1 Fixed Priced Contracts

A fixed price for the defined amount of work (Ibbs et al., 1986) with minor variations as indicated below. Further sub-classifications can be:

2.3.2 Lump Sum

- Lump Sum – fixed price for execution of well defined scope of work.
- Lump Sum Turnkey – fixed price for design, procurement and construction.
- Lump Sum Procure and Build – fixed price for procure and build.

2.3.3 Unit Price

Unit Price Contracts have detailed list of work to be done at unit rates but the quantities shown are estimated. The contractor is paid at these unit rates based on the actual quantities of work executed. The risk of change in qty is with the owner (Ayers, 1988).

2.3.4 Guaranteed Maximum

Contracts which fix the maximum payable amount for the defined scope of work with incentives (Ashly and Workman 1986) for the contractor for cost under run and penalties for cost over runs.

2.3.5 Cost-Reimbursable Contract

Cost reimbursable contracts the contractor a price adjustment relative to project costs. Ibbs et al (1986) propose that they can be classified as :

2.3.5.1 Cost Plus Fixed Fee

The contractor in this type of contract is paid whatever cost is associated with the project plus a lump sum fee for overhead and profit.

2.3.5.2 Cost Plus Percentage

The contractor in this type is paid all associated cost plus a percentage rather that a fixed sum or fee.

2.3.5.3 Target Price Plus a Fee

The target price is based on the project cost on contract document or unit prices. ‘The contractor's fee will be based on this sum. 'Typically financial arrangements make provision for the contractor to share any savings below the target price or anticipated in the liability of cost overruns’ (Ayers, 1998).

According to Ayers (1998), this contract type associated with good quality at higher cost. The block diagram below depicts the contract form division:

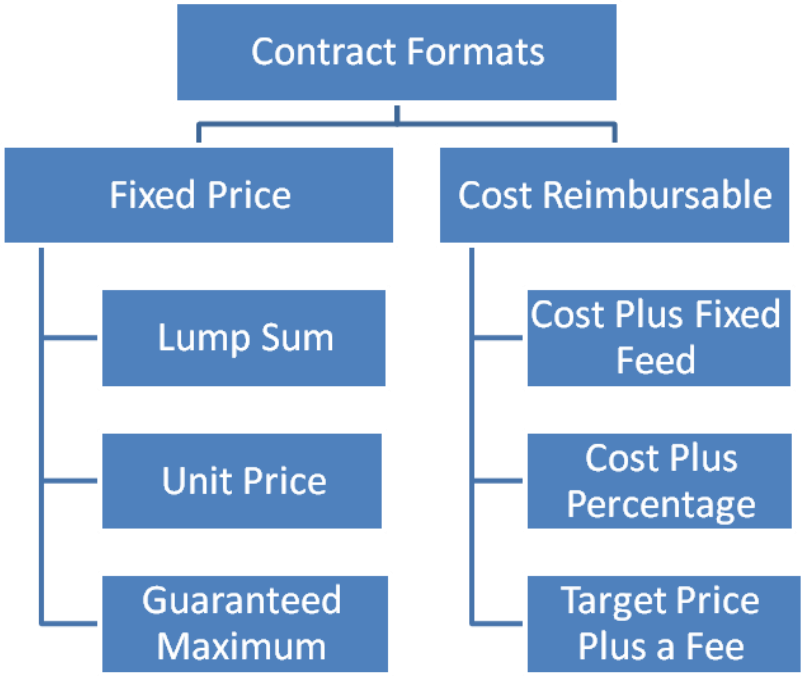


Figure 2 Contract form division (Source: Ayers 1998)

Contracts can also be classified based on the scope into Engineer-Procure-Construct (EPC), Design& Build (D&B), Build-Own-Operate-Transfer (BOOT) and Build-Operate-Transfer (BOT). The BOOT and BOT an additionally Design-Build-Finance-Operate (DBFO) type of contracts are gaining popularity (Webb, 1995)

Contracts can also be classified into single (one principal contractor) and partial (many contractors doing partial scope) (Ayers, 1998). There are various other forms of contracts like design build, multiple primes, general contractor, etc. (Webb, 1995).

Fixed price contracts are more sensitive to changes (Resmond, 1984) and are mostly used for well defined scope with low risks. Cost reimbursable contracts are used for ill-defined contracts or for schedule acceleration.

2.4 Variations causes

Arain (2005) quoting various sources states that "variations are common in all construction projects." (Construction Industry Institute, 1994; Fisk, 1997; Ibbs et al, 2001). Thus variations have a definite impact on the success and failure of a project and hence a significant amount of work has been done by researchers to identify the various types of variations and their causes.

Koushki and Kartan (2004) quoting Hafez (2001) assert that the implementation of construction projects is usually accompanied with time delays and cost increases. Their assertion is supported by Morris and Hough (1998) whose extensive examination of more than four thousand construction projects revealed that such projects were rarely finished on time or within cost. A similar outcome has been observed by various other researchers worldwide (Koushki and Kartan (2004) citing Al Hammad, 1993; Arditi et al, 1985; Rad 1979; Taha et al., 1993).

The subject of the causes of variations had also been explored by a large number of researchers who have adopted different methodologies for classifying such causes. For example, Hensey (1993) has proposed a classification system which 'included materials, labor, equipment and financial constraints as the main contributory variable to causes of construction delays' (Koushki and Kartan, 2004). These same authors have also referenced a list of factors compiled and duly ranked by Majid and McCaffer (1998) and contributing to the cause of non-excusable delays reproduced below:

Factors	Rank
Late material delivery or slow mobilization	1
Damaged materials	2
Poor planning	3
Equipment breakdown	4
Improper equipment	5
Unreliable supplier/subcontractor	6
Inadequate fund allocation	7
Poor quality	8
Absenteeism	9
Lack of facilities	10
Inappropriate practices/procedures	11
Lack of experience	12
Attitude	13
Poor monitoring and control strike	14
Shortages of personnel	15
Delay payment to supplier/contractor	16
Inefficient communication	17
Wrong method statement	18
Unavailability of proper resources	19
Deficient contract	20
Interference with other traders	21
Too many responsibilities	22
Subcontractor bankruptcy	23
Low morale/motivation	24

Table 3 non-excusable delays

(Source: Majid and McCaffer 1998: 42-48)

Koushki and Kartan (2004) concluded that 'nearly one fourth of the project delays were due to late delivery of materials'.

Fritz (1994) based on his vast experience in multifaceted projects has highlighted design developments, scope changes, recognition of actual site conditions, project schedule adjustments, code changes and unusual weather conditions as examples for the causes of change orders or variations.

Arain (2005) has provided interesting facts on the nature of variations and proved that nearly 39.21% of the cases, the causes of variations were related to Owners, while in 54.63% they were related to the Consultants and only about 3.22% were related to the Contractor. He further investigated the root causes of variations and summarized that the major cause of these variations was change of plans or scope by owner and change in specifications by owner while non-compliance design with government regulations, design discrepancies and change in design were the chief causes from the consultants.

Bower (2000) asserts that variations may arise due to lack of 'a truly systematic basis for the valuation of interim payments and changes'. On the other hand Al Momani (1996) citing Baldwin and Manthei (1971) states the major cases of delays as weather, labour supply and subcontractors. He also cites Chalabi and Camp (1984) who identified that in developing countries 'adequate planning at the early stages of a project is crucial for minimizing delays and cost overruns' and hence require appropriate variations. Long et al (2004) summarized the critical success factors for construction projects under the "4 Coms" viz. comfort, competence, commitment and communication. Hence any lapse in these factors may affect the projects timely completion within budget and as per specifications leading to a variation.

Components	Eigen value	Percentage of variance	Success factor	Factor loading
1	4.529	34.841	Adequate funding throughout the project	0.800
			comprehensive contract documentation	0.652
			availability of resources	0.638
			continuing involvement of stakeholder in the project	0.591
			Competent project manager	0.571
2	1.807	13.897	Up to date technology utilization	0.774
			Proper emphases on past experience	0.750
			Multidisciplinary competent project team	0.660
			Awarding bids to the right design/contractor	0.652
3	1.448	11.138	Commitment to project	0.879
			Clear objectives and scope	0.737
			Top management support	0.706
4	1.118	9.137	Community involvement	0.804
			Clear information and communication channels	0.737
			Frequent progress meeting	0.596

Table 4 Result of the factor analysis

Influencing components	Principle components Componenet1 First COM- comfort	Components 2 Second COM- Competence	Components 3 Third COM Commitment	Component 4 Fourth COM- Communication
1	Adequate funding throughout the project	Up to date technology utilization	Commitment to project	Community involvement
2	Comprehensive contract documentation	Proper emphasis on past experience	Clear objectives and scope	Clear information/communication channels
3	Availability of resources	Multidisciplinary/competent project team	Top management support	Frequent progress meeting
4	Continuing involvement of stakeholders	Awarding bids to the right design/contractor		
5	Competent project manager			

Table 5: Factor analysis grouping for success factor

In a major study undertaken by Yogeswaran and Kumaraswamy (1996) to investigate the sources of claims for time or cost, the following eight categories were considered as significant:

. Variations
. Unclear documentation
. Inadequate documentation
. Different Perceptions in assessment of claims for extensions of time
. Measurement Related Issues
. Instructions not being given during construction
. Specifications
. Inadequate Site Investigations

We would propose that while "variations" in the foregoing may be said to refer to the actual variations, the remaining list represents the categorized causes of these variations. The authors have further dealt in detail with the root causes of such claims/variations and have given a list of such causes under each category as reproduced below:

"SOURCE: Variations

Corresponding Causes:

- Change of design to suit site conditions.
- Interference of permanent works with utility lines.
- Employer's desire to incorporate latest changes in scope during construction.
- Contractor considers that the varied works were carried out under dissimilar conditions to those contemplated in the original works, while Engineers consider the conditions were similar.
- Lack of records supplied by the Contractor to substantiate claimed resources.
- Engineer / Contractor adversarial relationship.
- Contractor considers that the contract rates are too low and hence work should be valued at new rates. Engineer disagrees.

SOURCE: Unclear documentation

*Corresponding Causes***:**

- Inadequate time allowed for project documentation.
- Very late changes initiated by the Employer.
- Inadequate experience of Project Engineer(s) assigned to prepare documents.
- Incorrect choice of contract system.

SOURCE: Inadequate documentation

Corresponding Causes:

- Incomplete design at the time of tender.
- Inconsistent information in drawings.
- Late changes initiated by the Employer, causing discrepancies in the documentation.
- Solutions to constraints (such as inadequate borrow materials) do not cover every eventuality.
- Lack of coordination between different design teams at pre-contract stage.
- Inadequate brief from the Employer.

SOURCE: Different perceptions in assessment of claims for extension of time

Corresponding Causes:

- Effect on critical activities.
- Criteria for determining date for substantial completion is unclear.
- Time of notification of claim - compared to when the event occurred, etc.

SOURCE: Measurement related issues

Corresponding Causes:

- Employer/Engineer's errors in quantities in tender.
- Items that were not itemised and measured.
- Discrepancy between standard method of measurement and particular preamble.
- Discrepancy between items measured in BOQ and standard method of measurement.
- Errors/ambiguities in description of items.
- Inadequate item coverage in standard method of measurement.
- Disagreement on measurement lines.

SOURCE: Instructions not being given during construction

*Corresponding Causes***:**

- Engineer delays the issue of instruction when the Contractor requests for information / clarification.

- When two drawings show different dimensions, the Engineer issues instruction clarifying the details (i.e. providing correct information), but the Contractor considers that the instruction is a variation.
- Cases such as: e.g. Drawings indicate that the manholes should be extended to revised road levels. No details for extension were shown on tender drawings- Contractor requests instruction under variation.

{(a) Engineer requests Contractor's proposal

(b) Engineer issues instruction (as clarification)}.

SOURCE: Specifications

Corresponding Causes:

- Inadequately described method or performance specification.
- Use of documents prepared for previous contract and not specific to current Contract
- "OR EQUAL" specification.
- The specification leads to non-constructability (defective specification /tolerances).
- Use of untried/ unfamiliar products.
- Ambiguities - "phrasing"/ "typographical error".

SOURCE: Inadequate Site Investigations

Corresponding Causes:

- Employers do not allocate sufficient budget for site investigation.
- Contractor's risk in respect of unforeseen ground conditions is significantly reduced with the increase in available information from site investigation.
- Inconsistent interpretation of site investigation reports by the Contractor and Engineer."

(Source: Yogeswaran and M. M. Kumaraswamy, 1996)

Dissanayaka and Kumaraswamy (1999) citing Walker (1997) state that the 'procurement method is a significant factor affecting construction time performance' while 'sound working relationships between the construction management team and client's team also helps to achieve good construction time performance' (Walker,1999). The opinion of Robinson (1996) that projects achieve 12% faster construction speed and 30% faster total project

delivery speed when not using a traditional procurement approach is highly significant. However Dissanayaka and Kumaraswamy also listed other factors such as managerial controls (Ireland, 1985); management organization and contextual variables (Rowlinson, 1988); top management support, client consultation, preliminary estimates, availability of resources and project manager performance (Belassi and Tukel, 1996). Dissanayaka and Kumaraswamy (1999) then went on to categorize the factors affecting project performance into two categories: procurement-related and non-procurement related and derived the following factors as the chief causes for cost and time over runs.

Factor Groups	Factors	Significance level
(A) Procurement system	-	-
(B) Project Characteristics	Level of location difficulties	0.0901
	Obstruction due to underground utilities	
	Levels of design complexity	0.0390
	Delays in approval process	
	Level of construction complexity	0.417
	Number of subcontractors involved	0.0690
	Unexpected group condition	0.0527
	Level of complexity due to changes	
	Frequency and significance of change order variations	-
		0.0116
(C)Team Performance	-	0.0121
(D) Client/client representative Characteristics	Client type	0.0016
	Client confidence in construction team	0.0672
	Previous experience of the construction team	0.0488
	Project team motivation and goal orientation	0.181
	Incentives given to the contractor	0.0956
	Risk sharing among the project team	
(E) Contractor Characteristics	Speed/frequencies of information flow	
	Request for information	
	Involvement of sun-contractor	
	Quality of the work of the sub-contractors	
	Effectiveness of cost control system	
	Degree of control over material cost	

Table 6 Significant factors associated with time over-run
Source: Dissanayaka and Kumaraswamy (1999), 272-282.

Factor Groups	Factors	Significance level
(A) Procurement system	**Payment modality**	0.0724
(B) Project Characteristics	Levels of goal difficulties	
	To complete the project within client specified program	0.0706
	Levels of location difficulties	
	Restriction due to environmental factors	0.0156
	Level of design complexity	
	Innovativeness of design	0.0221
	Level of construction complexity	
	Use of new technology	0.0182
	Levels of coordination complexity	
	Delays in making important project decision	0.095
	Communication between project team members	
	Levels of complexity due to changes	0.0123
	Frequently and significance of change orders/variations	
	Claims due to change orders	0.095
	--	0.01123
(C) Team Performance		--
	Client experience	
(D) Client/client representative Characteristics		0.0289
	Client confidence in construction team	
	Previous experience of the construction team	
	Project team motivation and goal orientation	0.056
	Risk sharing among the project team	
	Perceived profitability for all groups in the project team	0.0959
	Effectiveness of communication flow	0.0077
	Timely decision making	0.0742
	Level of equity among the project team	0.0461
	Frequently of schedule adjustments	0.0461
	Levels of risk retained by the client	0.0875
	Risk of quantity variation	
	Difficulty of obtaining payments	0.0162
	Delays interim payments	
		0.0071
	Strength of management staff of contractor	
(E) Contractor Characteristics	Senior staff	
	speed/frequencies of information flow	0.0786
	progress reports to client/consultants	
	submissions for approval	0.0786
	response to instruction	0.075
	effectiveness of cost control system	0.0041
	degree of control over material cost	
		0.0093

Table 7 Significant factors associated with cost over-run

(Source: Dissanayaka and Kumaraswamy 1999: 272-282)

Zaneldin (2006) focusing on the UAE construction industry summarized that there could be 26 possible causes of claims (and hence the causes for delays, cost overruns, quality aspects, etc) as given below:

Causes of claim	Average mean	Importance index(%)	Rank
Change or variation order	2.96	59.20%	1
Delay caused by owner	2.95	59.00%	2
Oral change order by owner	2.86	57.20%	3
Delay in payments by owner	2.75	55.00%	4
Low price of contract due to high competition	2.75	55.00%	4
Change in material & labor cost	2.63	52.60%	6
Owner personality	2.52	50.40%	7
Variation in quantities	2.52	50.40%	7
Subcontracting problems	2.48	49.60%	9
Delay caused by contractor	2.48	49.60%	9
Contractor is not well organized	2.48	49.60%	9
Contractor financial problem	2.45	49.00%	12
Bad quality of contractor's work	2.41	48.20%	13
Government regulation	2.30	46.00%	14
Estimating errors	2.23	44.60%	15
Scheduling errors	2.23	44.60%	15
Design error or omission	2.21	44.20%	17
Executing error	2.20	44.00%	18
Bad communication between parties	2.14	42.80%	19
Subsurface problems	2.13	42.60%	20
Specifications & drawing inconsistencies	2.07	41.40%	21
Termination of work	2.05	41.00%	22
Poorly written contract	1.98	39.60%	23
Suspensions of work	1.98	39.60%	23
Accidents	1.93	38.60%	25
planning errors	1.89	37.80%	26

Table 8 Ranking of the causes of claim (Source: Zaneldin, 2006: 453-459)

The author's research concluded to establish a well ranked list of factors for claims. The list is most significant since the research has been done on the projects undertaken in Abu Dhabi and Dubai and reflects the influence of local factors. Iyer and Jha (2005) have arrived at the following list of factors related to project failure.

		All response		Owner		contractor	
	Project attributes	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
1	Poor human resource management and labor strike	0.309	1	0.295	1	0.329	1
2	Negative attribute of P.M and project participants	0.341	2	0.350	2	0.329	3
3	Inadequate project formulation in the beginning	0.346	3	0.355	3	0.333	4
4	Vested interest of client representative in not getting project completed in time	0.350	4	0.365	4	0.329	1
5	Conflicts between PM and top management	0.355	5	0.345	5	0.370	8
6	Mismatch in capabilities of client and architect	0.367	6	0.374	6	0.357	7
7	Conflict between PM and other outside agency such as owner, sub-contractor or other contractor	0.368	7				
8	Reluctance in timely decision by PM	0.376	8	0.380	7	0.350	5
9	Lack of understanding of operating procedure by the PM	0.391	9	0.390	8	0.356	6
10	Conflicts among time members	0.391	10	0.379	9	0.407	13
11	Ignorance of appropriate planning tools and techniques by PM	0.397	11	0.390	10	0.393	11
12	Holding key decisions in abeyance	0.400	12	0.395	11	0.400	12
13	Reluctance in timely decision by top management	0.406	13	0.411	12	0.385	10
14	Harsh climate condition in the site	0.415	14	0.431	13	0.371	9
15	Hostile political & economic environment	0.430	15	0.395	14	0.444	16
16	Tendency to pass on the blame to others	0.441	16	0.445	15	0.408	14
17	Hostile social environment	0.455	17	0.445	16	0.436	15
18	Project completion date specified but not yet planned by the owner	0.478	18	0.442	17	0.471	18
19	Uniqueness of the project activities requiring high technical know-how	0.559	19	0.495	18	0.454	17
20	Urgency emphasized by the owner while issuing tender	0.588	20	0.589	19	0.515	19
21	Size and value of the project being large	0.672	21	0.575	20	0.608	20
22	Aggressive completion at tender stage	0.724	22	0.630	21	0.733	22
	Presence of crisis management skill of PM	0.771	23	0.774	22	0.652	21
				0.730	23	0.829	23

Table 9 Critical failure attributes of projects ($\mu \leq 3.5$)

Source: Iyer and Jha (2005) 314-322.

The conclusion of the authors was that 'coordination between project participants is the most important factor that has maximum influence in successful cost performance.'

Assaf and Al Hejji (2006) conducted a good survey of contractors, consultants and owners and were able to identify 73 causes of delays of which "change order" was the most prominent cause.

"Causes of delay in large construction Projects" Sadi A. Assaf, Sadiq Al-Hejji

No	Causes of delay	Group
1	Original contract duration is too short	Project
2	Legal disputes between various parts	Project
3	Inadequate definition of substantial completion	Project
4	Ineffective delay penalties	Project
5	Type of construction Contract (Turnkey, construction only..)	Project
6	Type of project bidding and award (negotiation, lowest bidder..)	Project
7	Delay in progress payments by owner	Project
8	Delay to furnish and deliver the site to the contractor by the owner	Project
9	Change orders by owner during construction	Project
10	Late in revising and approving design documents by the owner	Project
11	Delay in approving shop drawings and sample materials	Project
12	Poor communication and coordination by owner and other parties	Project
13	Slowness in decision making process by owner	Project
14	Conflicts between joint-ownership of the project	Project
15	Unavailability of incentives for contractors for finishing ahead of schedule	Project
16	Suspension of work by owner	Project
17	Difficulties in financing project by contractor	Project
18	Conflicts in sub-contractors schedule in execution of project	Project
19	Rework due to errors during construction	Project
20	Conflicts between contractor and other parties (consultant and owner)	Project
21	Poor site management and supervision by contractor	Project
22	Poor communication and coordination by contractor with other	Project

	parties	
23	Ineffective planning and scheduling of project by contractor	Project
24	Improper construction methods implemented by contractor	Project
25	Delays in sub-contractors work	Project
26	Inadequate contractor's work	Project
27	Frequent change of sub-contractors because of their inefficient work	Project
28	Poor qualification of the contractor's technical staff	Project
39	Delay in site mobilization	Project
30	Delay in performing inspection and testing by consultant	Project
31	Delay in approving major changes in the scope of work by consultant	Project
32	Inflexibility (rigidity) of consultant	Project
33	Poor communication/coordination between consultant and other parties	Project
34	Late in reviewing and approving design documents by consultant	Project
35	Conflicts between consultant and design engineer	Project
36	Inadequate experience of consultant	Project
38	Mistakes and discrepancies in design documents	Project
39	Delays in producing design documents	Project
40	Unclear and inadequate details in drawings	Project
41	Complexity of project design	Project
42	Insufficient data collection and survey before design	Project
43	Misunderstanding of owner's requirements by design engineer	Project
44	Inadequate design-team experience	Project
45	Un-use of advanced engineering design software	Project
46	Shortage of construction materials in the market	Project
47	Changes in material types and specifications during construction	Project
48	Delay in material delivery	Project
49	Damage of sorted material while they are needed urgently	Project
50	Delay in manufacturing special building materials	Project
51	Late procurement of materials	Project
52	Late in selection of finishing materials due to availability of many	Project

	types in the market	
54	Equipment breakdowns	Project
55	Shortage of equipment	Project
56	Low level of equipment-operator's skill	Project
57	Low productivity and efficiency of equipment	Project
58	Lack of high-technology mechanical equipment	Project
60	Shortage of labors	Project
61	Unqualified workforce	Project
62	Nationality of labors	Project
63	Low productivity level of labors	Project
64	Personal conflicts among labors	Project
66	Effects of subsurface conditions (e.g. soil, high water table, etc.)	Project
67	Delay in obtaining permits from municipality	Project
68	Hot weather effect on construction activities	Project
69	Rain effect on construction activities	Project
70	Unavailability of utilities in site (such as water, electricity, telephone, etc)	Project
71	Effect of social and cultural factors	Project
72	Traffic control and restriction at job site	Project
73	Accident during construction	Project
74	Differing site (ground) conditions	Project
75	Changes in government regulations and laws	Project
76	Delay in providing services from utilities (such as water, electricity)	Project
77	Delay in performing final inspection and certification by a third party	Project

Table 10: Causes of delay in large construction projects

The authors summarized the most important causes for delays as identified by the three main stakeholders (i.e owners, contractors and consultants) were as follows:

Sl No.	Owners	Contractors	Consultants
1	Shortage of labour	Delay in progress payments by owner	Type of project bidding and award
2	Unqualified work force	Late in reviewing and approving design documents by owner	Shortage of labors
3	Ineffective planning and scheduling of project by contractor	Change orders by owner during construction	Delay in progress payment by owner
4	Low productivity level of labors	Delays in producing design documents	Ineffective planning scheduling of project by contractor
5	Hot weather effect on construction activities	Late in reviewing and approving design documents by consultant	Change orders by owner during construction
6	Conflicts encountered with sub-contractor's schedule in project execution	Difficulties in financing project by contractor	Low productivity level of labors
7	Poor site management and supervision by contractors	Mistakes and discrepancies in design documents	Difficulties in financing project by contractor
8	Inadequate contractor's experience	Late procurement of materials	Poor site management and supervision by contractor
9	Effects of subsurface conditions (soil, existing of utilities, high water table, etc)	Inflexibility (rigidity) of consultant	Poor qualification of the contractor's technical staff
10	Change orders by owners during construction	Slowness in decision making process by owners	Delay in material delivery

Table 11: Most important causes for delays

The most important conclusion made by the authors was that ‘owners and consultants realize that awarding to the lowest bidder is the highest frequent factor of delay’. The second significant conclusion by the authors was that ‘change order by owner during construction’ was the only common factor amongst the three stakeholders. The authors proceeded to provide a good list of recommendations based on the study which will be addressed in the relevant area in the dissertation.

Faridi and E-Sayegh (2006) have given attention to delay factors in the construction industry in the UAE. The results and rankings obtained by them are reproduced below:

S. N	Category	Causes of delay	Contractors		Consultants		5-10 years		10 years		Overall	
			RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Contractor	Shortage of manpower	2.362	8	2.333	4	2.323	4	2.489	1	2.348	4
2		Skill of manpower	2.244	12	2.318	5	2.300	6	2.340	6	2.281	7
3		Productivity of manpower	2.362	8	2.227	7	2.438	2	2.170	16	2.297	6
4		Shortage of material on site	2.413	5	1.976	16	2.094	13	2.283	9	2.205	12
5		Non-availability of material on time	2.292	10	2.267	6	2.258	8	2.362	5	2.280	8
6		Shortage of equipment	1.911	28	1.867	20	1.656	30	1.979	25	1.889	28
7		Failure/breakdown of equipment	1.354	39	1.378	33	1.344	35	1.349	40	1.366	41
8		Defective work	1.638	35	1.600	31	1.581	32	1.652	37	1.620	38
9		Construction method	1.958	23	1.814	23	2.000	18	1.804	32	1.890	27
10		Construction mistakes	1.804	32	1.636	28	1.767	27	1.739	35	1.722	33
11		Poor supervision & poor site management	2.447	3	2.222	8	2.313	5	2.255	11	2.337	5
12		Inadequate contractor's experience	2.000	20	1.955	17	2.000	18	2.196	14	1.978	22

13		Delay in subcontractor's work	2.146	15	1.818	22	1.844	23	2.067	21	1.989	21
14		Necessary variation	1.689	34	1.558	32	1.516	34	1.822	31	1.625	37
15		Poor control of site resource allocation	1.830	31	1.818	22	1.742	28	1.907	28	1.824	29
16		Unsuitable leadership style of construction/project manager	2.298	9	2.133	10	2.094	14	2.298	8	2.217	11
17		Delay in special manufactured imported materials	2.109	17	1.867	20	1.903	22	2.000	24	1.989	21
18	Consultant/ Designer	Preparation al & approval of drawing	2.521	2	2.467	1	2.656	1	2.383	4	2.495	1
19		Waiting time for sample/material approval	2.106	18	2.000	14	1.938	20	2.022	23	2.054	19
20		Waiting time for site inspection & approval of quality control tests/results	1.193	27	1.727	26	1.969	19	1.870	30	1.822	30
21		Change in drawing	1.896	29	1.978	15	1.938	20	2.064	22	1.935	23
22		Change in specification	1.979	21	1.800	24	1.813	24	1.915	27	1.892	26
23		Incomplete drawing/specification/documents	2.298	9	1.978	15	2.188	11	2.130	19	2.141	15
24		Design error due to unfamiliarity with the local condition, environment & the material	1.851	30	1.622	29	1.625	31	1.804	32	1.739	32
25		Change order	1.696	33	1.698	27	1.581	32	1.727	36	1.697	35
26	Owner	Slowness of the owner's decision-making process	2.217	4	2.378	2	2.375	3	2.457	2	2.398	3

27		Material type & specification change during construction	2.191	13	2.111	11	2.094	14	2.239	12	2.152	14
28		Excessive bureaucracy/uncooperative owner	2.128	16	1.933	18	2.032	16	2.146	18	2.033	20
29	Owner	Unrealistic contract duration imposed by client	2.104	19	2.070	12	2.063	15	2.261	10	2.088	18
30	Financial	Financing by contractor during construction	2.170	14	2.356	3	2.281	7	2.304	7	2.261	10
31		Delay in contractor's progress payment (of completed work) by owner	2.250	11	2.133	10	2.125	12	2.217	13	2.194	13
32		Late payment to subcontractor by the main contractor	1.935	25	2.023	13	1.806	25	2.067	21	1.978	22
33	Planning & Scheduling	Inadequate early planning of the project	2.522	1	2.333	4	2.250	9	2.435	3	2.429	2
34		Lack of data in estimating activity duration & resources	1.957	24	2.000	14	1.806	25	2.149	17	1.978	22
35		Overestimation of the productivity	1.979	22	1.864	21	1.774	26	2.087	20	1.924	24
36		Inadequate progress review	1.553	36	1.867	20	1.625	31	1.795	33	1.707	34
37		Unavailability of the construction/project management group for the project	1.915	26	1.932	19	1.9o3	22	1.978	26	1.923	25
38	Contractual relationship	Lack of communication & coordination between the parties involved in	2.383	7	1.867	20	2.031	17	2.191	15	2.130	16

		construction (contractor-subcontractor-consultant-owner)										
39		Contract modification	1.696	33	1.619	30	1.906	21	2.239	12	1.659	36
40	Government regulation	Obtaining permit/approval from the municipality/different government authorities	1.383	7	2.159	9	1.548	33	1.796	34	2.275	9
41		Transportation permit	2.467	37	1.372	34	2.226	10	2.217	13	1.420	39
42	Unforeseen condition	Subsurface soil condition(geological problem/water table proble,etc0	1.830	31	1.750	25	1.300	36	1.533	39	2.261	10
43		Weather condition(mainly high temperature)	1.429	38	1.378	33	1.677	29	1.894	29	2.194	

Table 12: Delay factors

The most important outcome of the above research was that the authors identified the 10 most significant factors responsible for project delays in the construction industry as follows:

1. Preparation and approval of drawings
2. Inadequate early planning of the project.
3. Slowness of the owners decision making process
4. Shortage of manpower
5. Poor supervision and poor site management
6. Productivity of manpower
7. Skill of manpower
8. Non-availability of materials on time

9.Obtaining permit/approval from municipality/different government authorities

10. Financing by contractor during construction

We end our literature survey on the capstone study on conflicts, claims and disputes in the construction industry undertaken by Kumaraswamy (1996) where the author has been able to

provide us with two very valuable summaries. The first one defines the common categories of the claims as reproduced below:

General claim category	Overall		Contractors		Clients		Consultants	
	Rank	Index	Rank	Index	Rank	Index	Rank	Index
Variation Due To Site Condition	1	58.2	1	67.5	2	48.6	4	58.6
Variation due to client changes	2	55.6	2	60.0	4	46.7	1	60.0
Variation due to design errors	3	54.4	3	47.5	1	57.1	3	58.6
Unforeseen ground condition	4	49.0	4	45.0	5	49.1	2	60.0
Ambiguities in contract documents	5	43.0	6	30.0	3	47.6	9	51.4
Variation due to external events	6	40.6	5	37.5	7	40.0	10	44.3
Interference with utility lines	7	40.5	7e	30.0	6	40.0	8	51.4
Exceptional inclement weather	8	40.2	9	30.0	9	36.2	5	54.3
Delayed site possession	9	39.4	7e	30.0	10	35.2	6	52.9
Delayed design information	10	34.5	12	12.5	8	38.1	7	52.9

Table 13 perceived significance of common categories of construction claim, as perceived by contractors, clients and consultants, and listed in descending order of overall perceived significance.
(Source: Kumaraswamy 1996, V.2)

The second summary table by the author lists the common causes of claims as perceived by contractors, clients and consultants.

General claim category	Overall		Contractors		Clients		Consultants	
	Rank	Index	Rank	Index	Rank	Index	Rank	Index
Variation Due To Site Condition	1	57.3	1	62.5	4	45.3	1	64.3
Variation due to client changes	2	50.6	4	50.0	2	54.3	5	54.3
Variation due to design errors	3	49.3	5	50.0	5	42.1	4	55.7
Unforeseen ground condition	4	46.9	3	50.0	11	37.9	6	52.9
Ambiguities in contract documents	5	45.7	10	40.0	12	35.8	2	61.4
Variation due to external events	6	45.0	2	52.5	7	41.1	12	41.4
Interference with utility lines	7	44.6	15	30.0	3	45.3	3	58.6
Exceptional inclement weather	8	44.1	12	35.0	1	51.6	10	45.7
Delayed site possession	9	41.9	6	42.5	13	34.7	8	48.6
Delayed design information	10	41.3	7e	40.0	6	41.1	11	42.9

Table 14: Perceived significance of common causes of claim, as perceived by contractors, clients and consultants, and listed in descending order of overall perceived significance.
(Source: Kumaraswamy 1996, V.2)

2.5 Time and Cost impact

Variations are of two types, namely beneficial variations and detrimental variations. Beneficial variations are those that actually help to improve quality, reduce cost, schedule, or degree of difficulty in the project. Detrimental variations are those that reduce owner value or have a negative impact on a project (Ibbs et al., 2001). The project team should be able to take advantage of beneficial variations when the opportunity arises. The need to make changes on a construction project is a matter of practical reality. Even the most thoughtfully planned project may necessitate changes due to various factors. The variations can be minimized when the problem is studied collectively as early as possible, since the problems can be identified and beneficial variations can be made (CII, 1994).

When the scope of a job is varied many tasks may be affected both directly and indirectly. Additional costs due to the direct effects of a variation, such as a change in resource requirements, are relatively easy to estimate. The indirect effects which are difficult to quantify can include:
rework and lost effort on work already done; time lost in stopping and restarting current tasks in order to make the variation; change in cash flow, financing costs, loss of earnings, loss of productivity due to reprogramming, loss of rhythm, unbalanced gangs and acceleration; revisions to project reports and documents; and loss of productivity, therefore increased sensitivity to delay (Bower 2000: 85-91).

Kaming et al. (1997) pointed out that the major factors influencing cost overrun were material cost increase due to inflation, inaccurate material estimating and the degree of project complexity. In the case of time overrun, the most important factors that caused delays were design changes, poor labour productivity, inadequate planning, and resource shortage.

Variations in construction projects can cause substantial adjustment to the contract duration, total direct and indirect cost, or both (Ibbs, 1997a; Ibbs et al., 1998). The most common effect of variations, during the construction phase, is the increase in project cost (CII, 1990). Any major additions or alterations in the design may eventually increase the project cost (Clough and Sears, 1994; Assaf et al., 1995). In every construction project, a contingency sum is usually allocated to cater for possible variations in the project, while keeping the overall project cost intact.

Variations during the project may affect the project progress and quality (CII, 1994; Assaf et al., 1995). Time has an equivalent money value even if the professional team tries its best to keep the project completion schedule intact. However, only major variations during the project may affect the project completion time. The contractor would usually try to accommodate the variations by utilising the free floats in the construction schedules. Hence, the variations affect the progress but without any delay in the project completion.

Completion schedule delay is a frequent result of variations in construction projects (Ibbs 1997b). The magnitude of the schedule being delayed due to variations was reported by Zeitoun and Oberlender (1993) to be 9 percent of the original schedule for 71 fixed price projects studied. Kumaraswamy et al. (1998) studied claims for extension of time due to excusable delays in Hong Kong's civil engineering projects.

The most frequent effect of variation orders was the completion schedule delay. Major variations may affect the project adversely, leading to delays in the project completion. Furthermore, frequent minor variations can also affect the project adversely depending on the timing of the occurrence of the variations. This is because the impact of a variation in design during the construction phase can be more severe than in the design phase (Arain and Pheng, 2005).

2.6 Types of Changes

Normally, construction changes refer to work state, processes, or methods that deviate from the original construction plan or specification. They usually result from work quality, work conditions or scope changes. 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. In this case, the design changes are a result to the designer, while they can be a need for changes to the construction crew. In addition, change can be also seen as an action of making a change which is further categorized into unintended change and managerial change. Unintended changes may occur without the intervention of managerial actions (Park, 2002).

2.7 Project Success

A construction project is commonly acknowledged as successful when it is completed on time, within budget, and in accordance with specifications and to stakeholders' satisfaction. Functionality, profitability to contractors, absence of claims and court proceedings and "fitness for purpose" for occupiers have also been used as measures of project success (Takim and Akintoye, 2002).

A project means that certain expectations for a given participant are met, whether owner, planner, engineer, contractor, or operator. The following are some other definitions of "project success" in general and in construction:

- Ashley et al. and Sanvido et al., (1992) referred to project success as having results much better than expected or normally observed in terms of cost, schedule, quality, safety, and participant satisfaction.

- de Wit (1988) remarked that a project is considered an overall success if it meets the technical performance specification and/or mission to be performed, and if there is a high level of satisfaction concerning the project's outcome among key people in the parent organization, key people in the project team and key users or clients of the project effort.

- Regarding construction projects, Sanvido et al. (1992) defined success for a given project participant as the degree to which project goals and expectations are met. They added that these goals and expectations may include technical, financial, educational, social, and professional aspects.

- Chua et al. (1999) proposed a hierarchical model for construction project success. The objectives of budget, schedule, and quality are key measures that contribute to the goal of "construction project success" – the top of the hierarchy. Similarly, the four main project aspects, namely project characteristics, contractual arrangements, project participants, and interactive process, measure the success of each of the three distinct objectives. Obviously, determining whether a project is a success or failure is intricate and ambiguous.

There are three main reasons among which Belassi and Tukel (1996) pointed out the first two. First, as mentioned by de Wit (1988) and Pinto and Slevin (1989), it is still not clear how to measure project success since project stakeholders perceive project success or failure differently. Second, lists of success or failure factors vary in numerous previous studies. The third reason, as also remarked by de Wit (1988), is that for each project stakeholder, the objectives and their priorities are set differently throughout the project life cycle and at different levels in the management hierarchy. It is necessary that distinctions be made between project success and project management success and between project success and project performance. Previous studies (de Wit, 1988; Munns and Bjeirmi, 1996; Cooke-Davies, 2002) clarified that project success is measured against the overall objectives of the project while project management success is measured against cost, time and quality/performance.

Cooke-Davies (2002) noted that there is a significant distinction between project success, which cannot be measured until after the project is completed, and project performance that can be measured during the life of the project. However, Baccarini (1999) insists that project success is measured both in terms of product (including facilities) success and project management success. Despite this controversy, this research follows the broad definition of project success as stated in Baccarini (1999). The reason is that this research aims to disseminate general success factors to project managers in Vietnam and other similar developing countries where the body of knowledge of project management is not lofty. The more complicated the dissection is, the less likely that the success factors and the lesson learned will be adopted for future projects. In a business context, a success factor is defined as any knowledge, skill, trait, motive, attitude, value or other personal characteristics that is essential to perform the job or role and that differentiates solid from superior performance (PEPDS, 2004).

2.8 Summary

The UAE has emerged as a region of significant construction activity. The volatile inflationary market related to materials and human resources is having a deep impact on the construction industry in the form of introducing variations for price, schedule, and scope adjustments. Consequently the successful management of variations has assumed considerable significance in UAE's project management methodology.

The literature review reveals that variations have been defined by researchers in more than one way. However, it would be reasonable to generalize and summarize variations as ‘any change in scope, schedule or cost’ which may arise either as a result of client request, design changes or due to unforeseen changes mandated by external factors such as site conditions, approvals and omissions, etc.

The literature review for this dissertation has revealed that variations in construction sector are not uncommon. These variations have been studied by a wide cross section of researchers in different geographical locations and with difference analytical methodologies, tools and techniques. Koushki and Kartan (2004) have proposed the highly cited "materials, labor, equipment and financial constraints" as the main contributory variables related to project delays and proposed that one fourth of the delays arise from material delays. Others have highlighted that design/scope changes, actual site conditions etc were responsible for variations.

In one interesting study (Arain, 2005) it was concluded the contractors were responsible for only 3.22 % of the variations while the owners and consultants were responsible for the remainder of the variations. The literature also revealed that weather, labor supply and sub-contractors were also critical factors giving rise to variations while lack of planning was a leading issue in developing countries. Long et al's (2001) critical success factors concentrated on the 4 coms - comfort, competence, commitment and communication. Yogeswaran and Kumarswamy (2001) have done detailed analysis of the causes for variations in construction industry and the outcome of their research can be said to cover most if not all the possible causes. Other authors have studied variations arising as claims and have developed a list of common causes of claims specially related to the UAE construction industry.

Thus it is clear that research on this subject has led to the development of an extensive list of factors and causes leading to variations. Hence, in order to study the causes of variations in the construction industry, the author has selected the highest rated factors from amongst the various lists of factors proposed by different researchers.

Based on the above literature review, it is evident that researchers have identified a large number of factors which may be responsible for affecting construction projects and leading to delays, variations and cost impacts. We have therefore given principal attention to the most highly rated factors from each researcher and developed the following list of factors to be used as the basis of assessing the reasons for variations in projects.

1.Shortage of required materials	2.Delay in materials delivery	3. Changes in materials prices
4.Changes in materials specification	5. Shortage of required equipment	6. Failure of equipment
7. Shortage of supporting and shoring installations for excavations	8. Inadequate equipment used for the works	9. Shortage of manpower (skilled, semi-skilled, unskilled labour)
10. Low skill of manpower	11. Lack of motivation among contractor's members	12. Shortage of contractor's administrative personnel
13. Shortage of technical professionals in the contractor' organization	14. Poor communications by the contractor with the parties involved in the project	15. Contractor's poor coordination with the parties involved in the project with the parties involved in the project
16. Slow preparation of changed orders requested by the contractor	17. Ineffective contractor head office involvement in the project	18. Delays in mobilization
19. Poor controlling of subcontractors by contractor	20. Loose safety rules and regulations within the contractor's organization	21. Poor qualifications of the contractor's technical staff assigned to the project
22. Improper technical studies by the contractor during the bidding stage	23. Ineffective planning and scheduling of the project by the contractor	24. Delays to field survey by the contractor
25. Ineffective control of project progress by the contractor	26. Inefficient quality control by the contractor	27. Delay in the preparation of contractor submissions
28. Improper construction methods implemented by the contractor	29. Difficulties in financing the project by the contractor	30. Cash flow problems faced by the contractor
31. Problems between the contractor and his subcontractors with regard to payments	32. Poor qualification of consultant engineer's staff assigned to the project	33. Delay in the preparation of drawings
34. Delay in the approval of contractor submissions	35. Poor communication between the consultant	36. Poor coordination by the consultant engineer with other

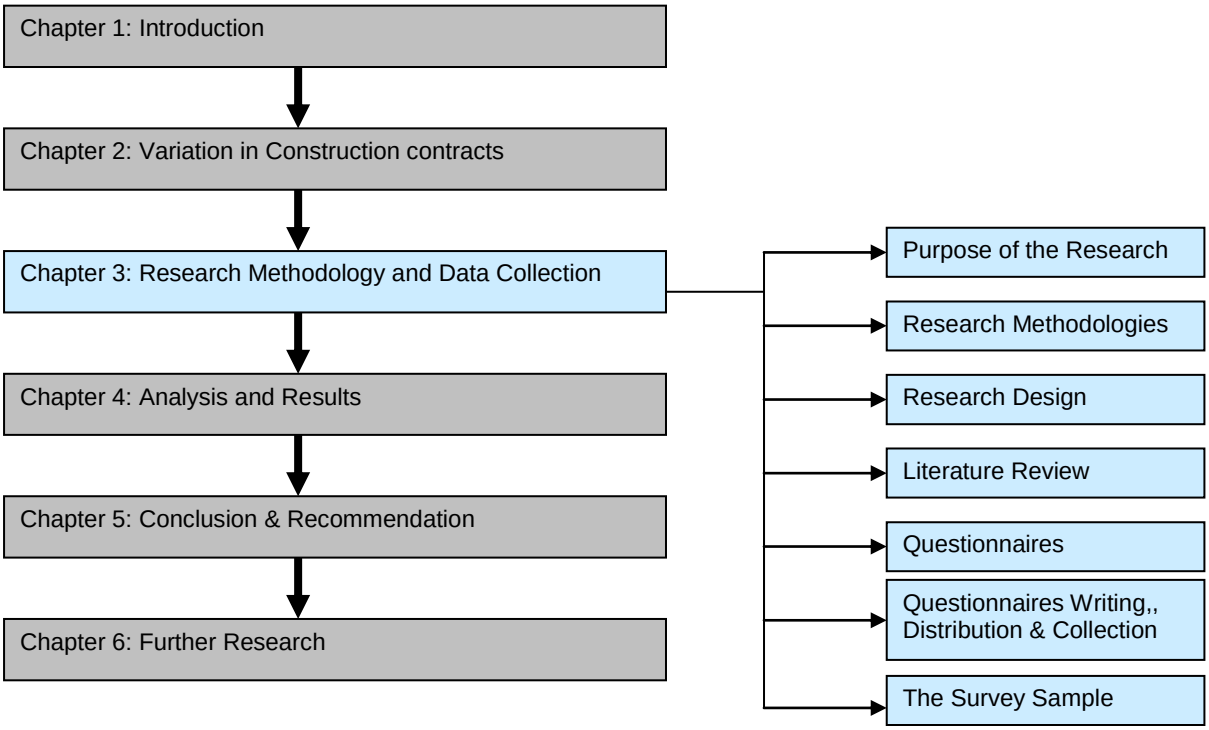
by the consultant	engineer and other parties involved	parties involved
37. Delays in performing inspection and testing by the consultant engineer	38. Slow response from the consultant engineer to contractor inquiries	39. Inadequate design specification
40. Poor contract Management	41. Delay in furnishing and delivering the site to the contractor by the client	42. Unrealistic contract duration
43. Delay in the settlement of contractor claims by the client	44. Suspension of work by the client's organization	45. Delay in issuing of change orders by the client
46. Slow decision making by the client's organization	47. Interference by the client in the construction operations	48. Uncooperative client with the contractor complicating contract Administration
49. Delay in progress payments by the client	50. Client's poor communication with the construction parties andgovernment authorities	51. Client's failure to coordinate with government authorities during planning
52. Poor coordination by the client with the various parties during Construction	53. Excessive bureaucracy in the client's administration	54. Changes in the scope of the project
55. Ambiguities, mistakes,and inconsistencies in specifications and drawings	56. Subsurface site conditions materially differing from contract documents	57. Original contract duration is too short duration is too short
58. Ineffective delay penalty	59. Difficulties in obtaining work permits	60. Government tendering system requirement of selecting the lowest bidding contractor
61. Changes in government regulations and laws	62. Severe weather conditions on the job site	63. Effects of subsurface conditions (type of soil, utility lines, water table)
64. Traffic control and restrictions on the job site	65. Effects of social and cultural conditions	66. Rise in the prices of materials
67. Work interference between various contractors		

Table 15: Variation causes

Chapter 3

3 Research Design and Methodology

Having stated the aim and objectives of this research in Chapter 1, setting out a picture of construction industries in the UAE in Chapter 2 and presenting the background of the subject in Chapter 3, it is time to present the methodology used to carry out this research and address its aims. This chapter explains how the problem was investigated and describes the tools used to undertake the investigation. It also describes the characteristics of the research sample and the method of analysis.



3.1 Purpose of Research

According to Yin (1994), there are three different ways of approaching the research namely: through descriptive, exploratory, or explanatory research. The goal of descriptive research is to develop and explain empirical generalizations (Yin, 1994). This type of research includes a complete description of a phenomenon with its context (Saunders et al. 2000) and is based on already existing theories and hypotheses (Yin, 1994). The second type, explorative research is particularly used when a problem is difficult to limit and when there is little or restricted research available on the topic (Wiedersheim-Paul & Eriksson, 1997). Explanatory research, explains causal relationships between cause and effect (Yin 1994) and the purpose with this research is to prove or disapprove that a relation takes place or has a certain characteristic (Wiedersheim-Paul & Eriksson, 1998; Yin, 1994).

3.2 Research Methodologies

There are two different methodologies used in most research papers, these methodologies are qualitative methodologies and quantitative methodology. I am going to discuss the two methodologies, select and then explain the methodology which I apply in my dissertation.

3.2.1 Qualitative research methodologies

This methodology 'involves a phenomenological perspective whereby researchers aim to understand report and evaluate the meaning of events for people in particular situations, that is, how their social world is structured by the participants in it. The focus of qualitative methodologies is the way in which participants (rather than the researcher) interpret their experiences and construct reality. Some examples are an unstructured interview, focus group, open-ended questionnaire and participant observation.

Interview **-** an interview may be tightly structured, semi-structured, unstructured, in depth or conversational. This methodology involves the researcher and the interviewee in a one-to-one situation and may be quite time consuming. The researcher may interview several people at different times using the same interview question schedule.

Participant observation **-** The researcher is immersed in the action being observed but their role as researcher is not obvious. An example of participant observation methodology occurs when the researcher goes into a shopping centre in a wheelchair or joins a group; in order to

study it. Researchers using participant observation must be aware of the ethical implications of this methodology. A methodology wherein the researcher's role is more in the open is the participant-as-observer methodology. In this, the researcher still participates in, as well as observes, the action being studied but does so with the knowledge of other participants.

Ethnographic study **-** The systematic collection of data derived from direct observation of the everyday life of a particular society, group or subculture. This methodology requires the researcher's immersion in the culture/subculture under study and is an interactive process. The researcher is interested in understanding the customary actions, beliefs, knowledge and attitudes of the social group as these are reflected in the ways of engaging in everyday life.

Focus group - A small group (3 - 8 persons) whose members are brought together by the researcher for an in-depth discussion on a specific issue or topic. The researcher plans an interview schedule and organises the time and place. A tape recorder is useful for the success of the in-depth use of this methodology. The techniques of conducting the focus group; are similar to conducting an in-depth interview, the researcher needs, however, to be able to manage up to eight people talking about the issue or topic'
(Source: http://hsc.csu.edu.au/pta/scansw/method.html).

3.2.2 Quantitative research methodologies

This 'involves those methodologies, such as closed surveys structured interviews and sociograms (diagrammatic representations of interactions between individuals) which enable data (concrete or conceptual) to be collected, measured and compared with a standard.
Survey - A methodology which can use different instruments such as observation, interview or a written list of questions called a questionnaire. Surveying is the process of conducting a study from representative samples of specific populations (for example, women in the workforce, Year 9 students, recent immigrants). If a questionnaire is used, it may be comprised entirely of closed questions, multiple-response questions, Likert scale questions (differential sliding scale or rating scale questions) or open-ended questions, or may be a combination of all question styles. Data recording sheets for observation or a short list of structured interview questions are two other instruments that can be used during a survey.

Observation - This methodology involves watching and recording behaviors within a clearly defined area. The researcher plays the role of passive observer and is, therefore, outside the action/s being observed and recorded.

Questionnaire **-** a commonplace instrument for collecting data beyond the physical reach of the researcher, that is, from a large or diverse sample of people. It is an impersonal instrument for collecting information and must, therefore, contain clear questions, worded as simply as possible to avoid any confusion or ambiguity since the researcher probably will not be present to explain what was meant by any one particular question. The questionnaire should be designed to fulfill a specific research objective; it should be brief and the sequence of the questions logical' (Source: http://hsc.csu.edu.au/pta/scansw/method.html).

In the light of above discussion, the aim and the basis of the research questions of this dissertation being descriptive cum exploratory, the selected approach for this thesis was a qualitative approach. This method is appropriate since the aim is to describe and gain a deeper understanding of the Variation Order (Change Order) and its influence on the Oil & Gas Development projects.

3.3 Research design

The research was designed to address the problem identified in 1.3 and achieve the objectives mentioned in 1.5. It was considered essential to obtain a full understanding of the study by setting out the various elements in a logical sequence, so as to avoid misunderstanding and problems in the research. The problem, aims, objectives and hypothesis of the research were therefore stated at the outset. In order to present clear ideas about variations in Oil and Gas Projects and to examine the hypothesis identified, it was decided to conduct two stages of study. The first is a comprehensive review of the relevant literature, starting with defining the variation orders in this research, then shedding light on all significant aspects of variation order as covered by previous work in the field. The second stage was to prepare a questionnaire which was then used to highlight and compare the main causes of variation order in Oil and Gas projects.

3.4 Literature review

The basic concern throughout the review stage was to identify some of the broader parameter likely to be relevant in studying variation order. In order to achieve to achieve the first objective (see 1.5), a systematic literature review was conducted, covering textbooks, institutional and statutory publications, periodicals, trade and academic journals, and seminar and conferences papers.

The objectives identified in 1.3.1 can be seen to have been addressed by the literature review in the following points: Variation causes, time and cost impact on the overall budget, type of variations and project success.

3.5 Questionnaire

The questionnaire was designed to meet the research aims and objectives and to test its hypothesis. First, the information presented in the previous chapter helped to broaden the author's knowledge and create an awareness of other issues that might not otherwise have been taken into account. A provisional version of the questionnaire was then developed to cover all aspects needed to accomplish the purpose of the research. However, it was also necessary to ensure that the questionnaire was reliable. For this reason, a quality control process was undertaken, starting by ensuring that each objective and hypothesis had questions corresponding to it, passing through a practical test in which a specialist was asked to fill in the questionnaire in order to examine the level of clarity, and ending with an approval procedure by the research supervisor.

The aim of the questionnaire is to identify the most important causes of variation order in Oil and Gas projects; however, it was also valuable to examine the ground that may cause these variations, including procurement methods and tendering arrangements. In addition, it was expected that the respondents' knowledge and experience would differ from one to another, and that this might have an impact on their answers, so attention was paid to addressing this point. A list of such ideas was considered in constructing the questionnaire

In order to present the questionnaire in a systematic way, it was decided to divide the questions into four sections: See Appendix A

Section One **–** questions concerned with person experience. This contains general questions about the profession, period of experience, sector and size of projects.

Section Two **–** questions dealing with contractual arrangement, including procurement methods and tendering arrangement.

Section Three **–** questions dealing with performance of the projects that the person has been involved in. this section identifies the number of projects that the person has participated in and then asks how many of them were varied and what the average variation was in terms of cost. It also has a question about the average variation that was authorized by the client, the party responsible for the variation and five most important causes of variation.

Section Four **–** this section includes the list of 67 causes of variation order in Oil and Gas Projects. Four scales were identified to calculate the frequency and occurrence and the degree of severity of each cause.

3.6 Questionnaire writing, distribution and collection

Four points were considered in order to obtain a high level of response:

- Providing a covering letter (see appendix B) to do the following:
    - Identify the type of research and the researcher name.
    - Explain the purpose and the benefits of the study.
    - Encourage the participants to fill in the questionnaire.
    - Inform the participants that their name, company name will not appear in the research.
- Structuring the questionnaire in a smart and attractive design.
- Presenting the questionnaire in a multi-option format, limiting open questions to only one question.
- Keeping the questionnaire as short as possible, but comprehensive enough, so that it could be completed in a short period of time.

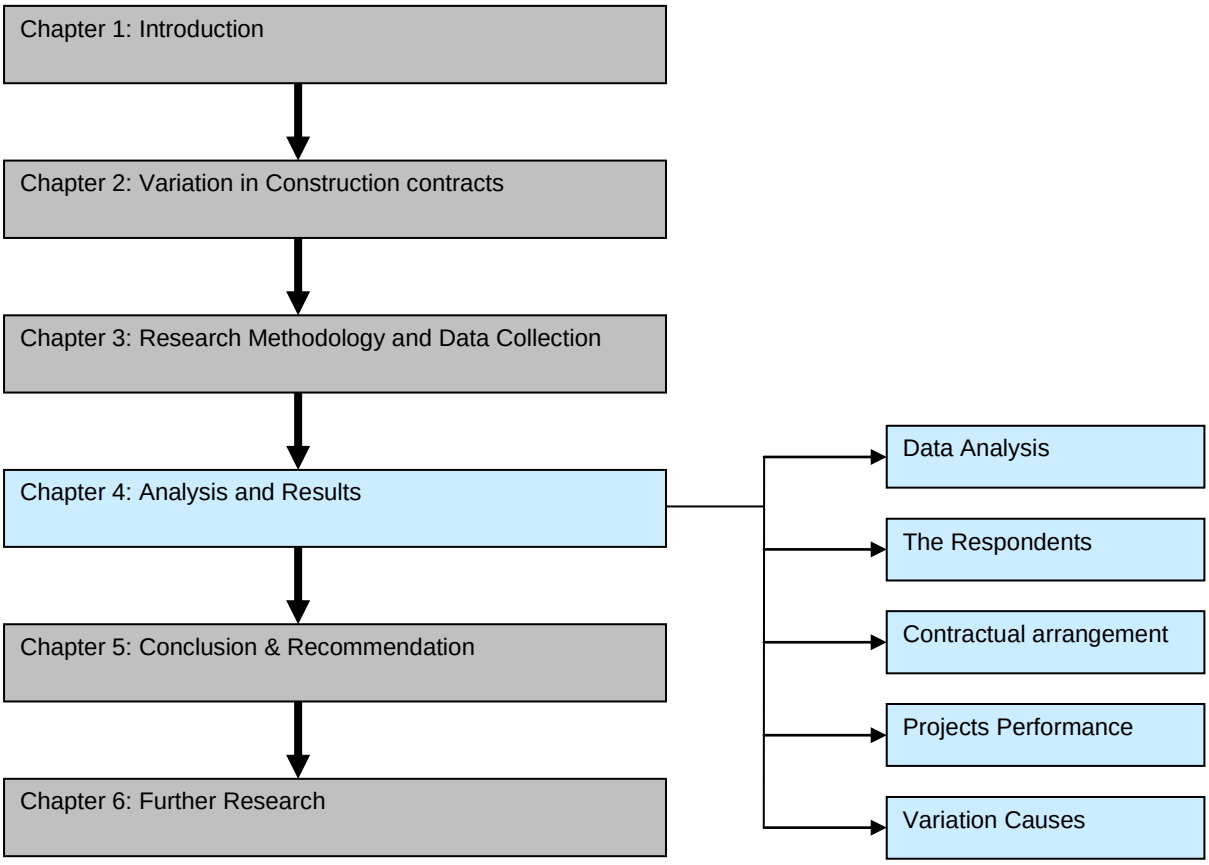
3.7 The survey sample

The population of this research is composed of three strata: owners, consultants and contractors working in Oil and Gas Projects.

Chapter 4

Analysis and Results

The methodology of analyzing the questionnaire having been presented in the previous chapter, the appropriate techniques that will be used to obtain the needed results from the survey are set out in Chapter 3. Here the results of the data collected through a questionnaire survey which was distributed among professionals working in the Oil and Gas Field are presented and discussed. This chapter consists of two major parts. The first part describes and analyses the data related to the respondents' experience, the contractual arrangements they have used, and the performances of the projects they have participated in. The second part focuses on the main objectives of this survey, presents and ranks the causes of Variation based on the opinions of different groups: each rank table is ordered according to the importance of the causes of Variation. The importance of these causes is based on the integration of their frequencies and severities.



4.1 Data Analysis

In order to discuss and analyse the results of the survey data collected, it was decided to present the analysis in the order shown in the questionnaire form. However, some results are needed to integrate more than one component to determine the relationship between them. Therefore the integrated results will be discussed as appropriate.

The analysis will be presented regarding to the total number of respondents; however, in some sections comparison of the data is required, and accordingly, is relevant to the professional groups. Therefore, the tables provided will illustrate these links which will be discussed as it seems useful and relevant to the objectives of this research. The next sections present and discuss data concerning respondents' experience, contractual arrangements, and the performance of the projects in which the respondents participated.

4.2 The Respondents

4.2.1 Stakeholder category

This section presents general information about the participation of respondents in this survey. The aim of this section is to give an image of the strength of respondents' experience, and therefore indicate the degree of reliability of the data provided by them.

Category		%
Client	19	29%
Consultant	26	40%
Contractor	20	31%
Total	65	100%

Table 16 Frequency of Participation

Table 16 and Figure 3 indicates the number of professionals who participated in this survey. The respondent was asked to select his/her business in the construction projects. The total number of respondents participating in this survey was 65. Consultants give the highest frequency, having 26 participants with 40%. Contractors come in the second position, with 20 participants and 31%. The lowest frequency is for owners with 19 participants and 29%.

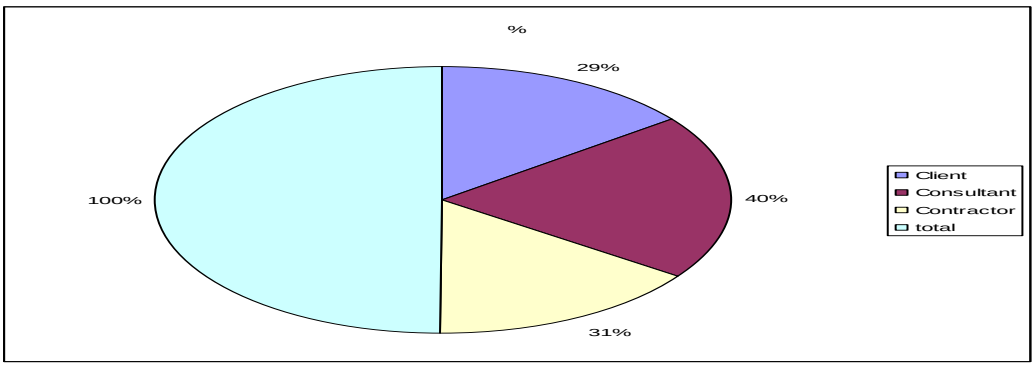


Figure 3 the percent of participants

4.2.2 Sector type

Respondents were asked to determine the sector type that they work for. Table X shows that the both the consultants and contractors' professionals work for both the private and public sector while clients only work for the private sector due to Oil and Gas being under government ownership. 46 out of 65 participants working in both public and private sectors while 19 out of 65 which they represent only client working for private sector.

Category	Sector type			
	Public	Private	Both	Total
Client	19			19
Consultant			26	26
Contractor			20	20
Total	19		46	65

Table 17 Sector types

The lowest rate of frequency is 19, and it is for client respondent which they are only working for private sector. The majority of respondent 46 which they represent both consultant and contractor are working for both the private and public sector. Figure 4 represents the proportion of respondents and the sector type they work for.

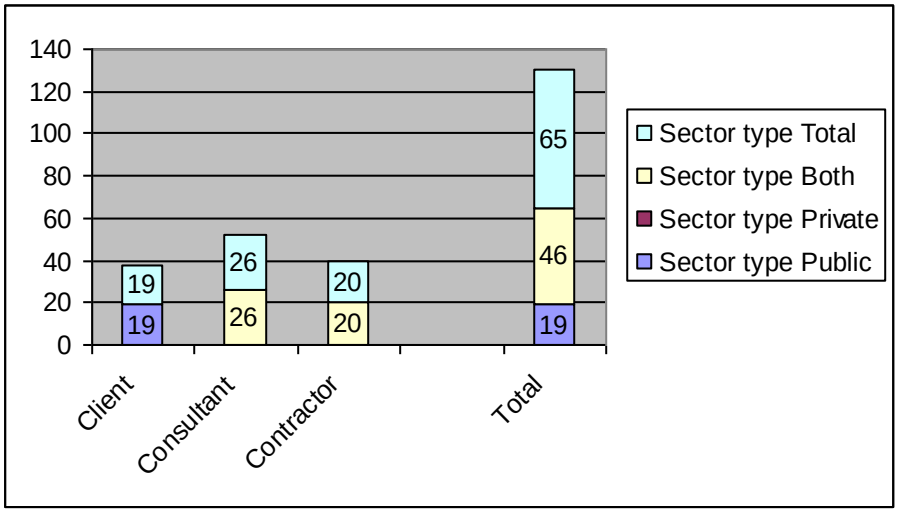


Figure 4 Sector types participants.

4.2.3 Years of Experience

Most of the professionals who participated in this survey have more than 10 years of experience, which in turn raises the reliability of the data collected since it arises from the shared knowledge of long years of experience in Oil and Gas projects.

category	Year Of experience				
	›5 years	5-10	10-15	›15	Total
Client	3	4	6	6	19
Consultant	6	8	9	3	26
Contractor	7	3	7	3	20
Total	16	15	22	12	65

Table 18: Participants' years of experience

4.2.4 Project Size

Table 19 illustrates the main categories of project sizes regarding the respondents' experience. It shows that the highest frequency deal with medium projects (44) followed by small projects (40), very large (37) and the lowest is large size projects (25).

category	Project Size				
	V. large	Large	Medium	Small	Total
Client	16	9	12	11	48
Consultant	13	9	15	18	55
Contractor	8	7	17	11	43
Total	37	25	44	40	
Total					146

Table 19 Project sizes

In terms of the four major categories, the medium size project is participated in by 44 respondents with 30%. Respondents dealing with small size projects are 40, which forms 28%. Very large size projects are participated in by 37 respondents with 25%. The large size projects category holds the lowest frequency (25) with 17%. As indicated in Figure 5.

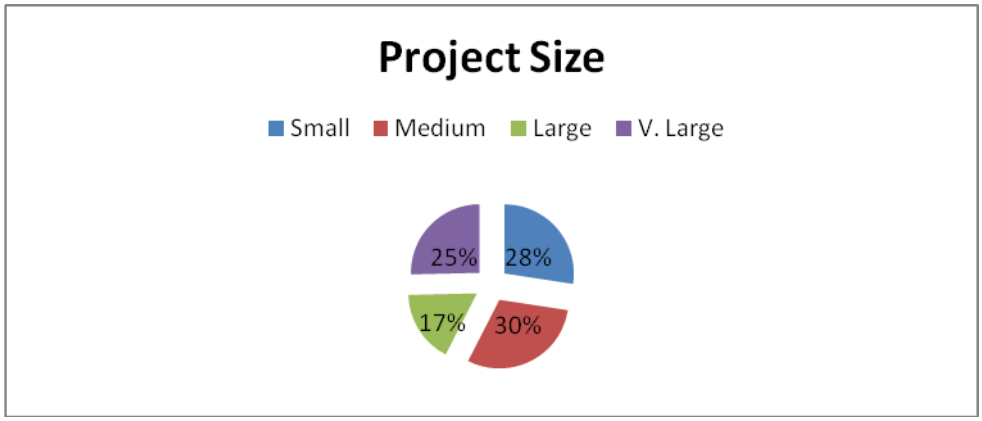


Figure 5 Project size

4.3 Contractual Arrangement

4.3.1 Procurement method

Various types of procurement methods are commonly used in construction projects. This variety of methods are grouped into four major categories (Traditional, Unit Rate, Design & Built and Reimbursable). The respondents were asked to select the method/s that they have experienced. Table 20 indicates that the majority of respondents has experience with Design and Built methods. The second frequency is for respondents who have dealt with Unit rate method. 28 of respondent have experience with reimbursable method whereas only 11 respondents dealt with the traditional method.

category	Procurement method					
	traditional	unit rate	design & built	reimbursable	others	Total
Client		13	20	4		37
Consultant	7	15	23	13		58
Contractor	4	12	16	11		43
Total	11	40	59	28		138

Table 20 Procurement method

Figure 6 shows that the type of procurement method that is most commonly used by respondents is Design and Built procurement method which is used by 59 participants. In contrast, the lowest frequency is for the traditional procurement method, which is used only by 11 participants. Unit rate and reimbursable procurement method come in between: 40 have dealt with unit rate and 28 have been involved in projects using the reimbursable procurement method.

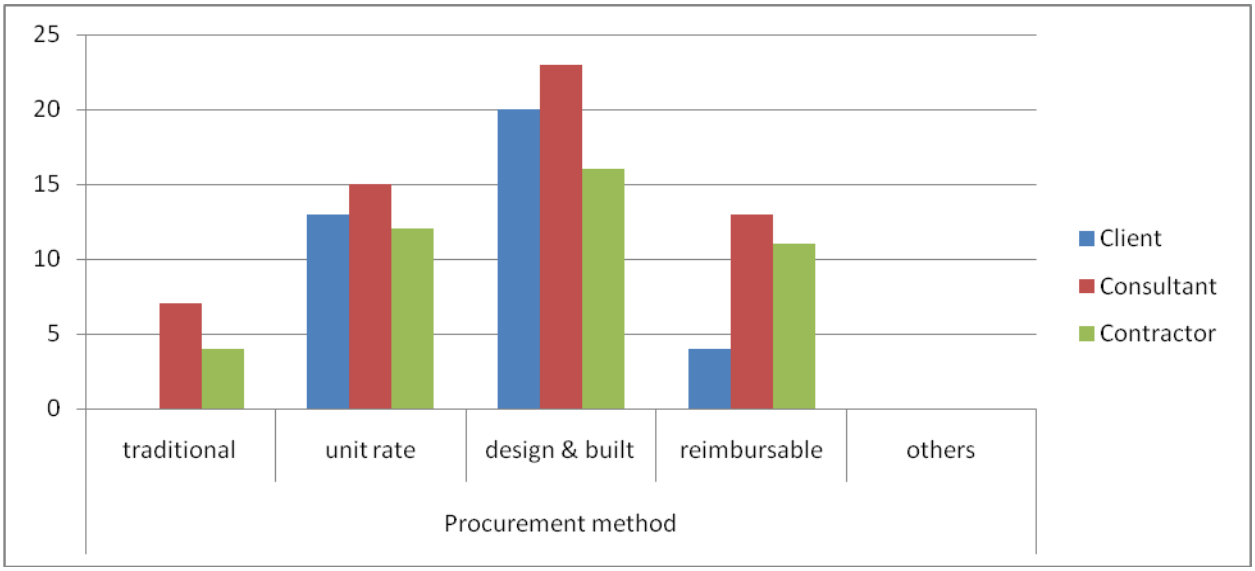


Figure 6: Procurement method

4.3.2 Tendering Arrangement

Four main categories of tendering arrangements were identified in the questionnaire (Negotiating, open tendering, selective tendering and two stage selective tendering), and respondents were asked to select the arrangement they have dealt with. Table 21 shows that all respondents have been involved in all tendering arrangements. 49 of respondents have been involved in open tendering, 27 participants involved in negotiating tendering arrangement, 17 respondents have been involved in selective tendering arrangement and only 14 participants involved in two stage tendering arrangement.

category	Tendering arrangement					
	Negotiating	Open Tendering	Selective tendering	two stage selective tendering	others	Total
Client	12	20	5	6		43
Consultant	7	16	8	3		34
Contractor	8	13	4	5		30
						0
Total	27	49	17	14		107

Table 21: Tendering arrangement

Figure 7 indicates that open tendering has been experienced by most in tendering arrangement and was selected by almost 50, followed directly by negotiation tendering and

selective tendering, which are experienced by 27 and 17. On the other hand, two stage tendering holds the lowest frequency, experienced by only 14 participants.

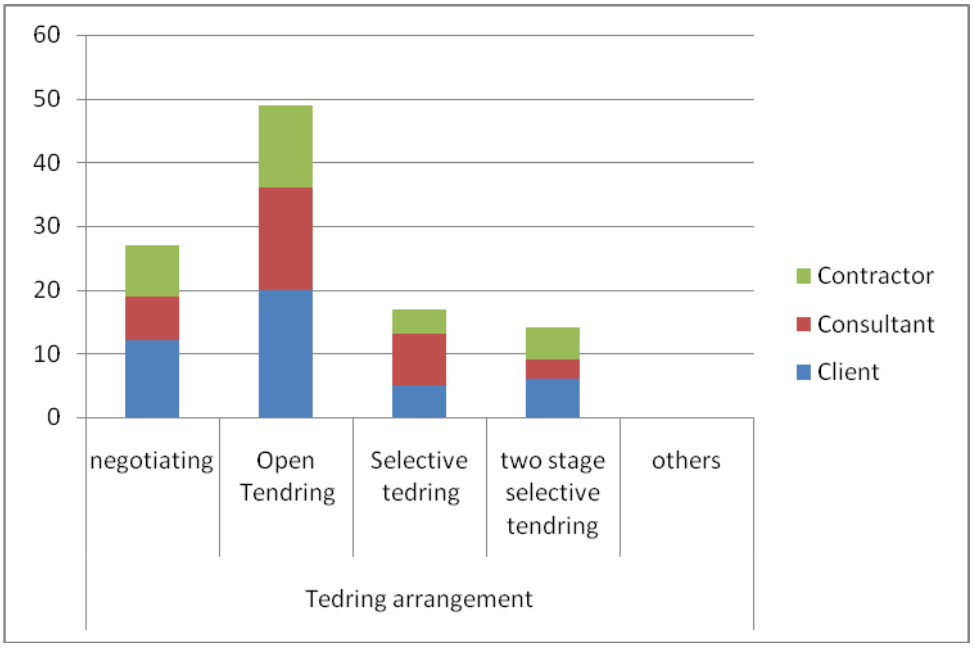


Figure 7: Tendering arrangement

4.4 Projects Performance

This section presents the core data analysis about the construction projects performance that participants have been involved in. It discusses and analyses the number of projects; how many of them were varied, the average time of variation, authorised time, and the first responsible party for variation.

4.4.1 Number of construction projects that respondents participated in

Table 22 indicates that the participation of professionals in this survey is based on over 395 projects they have been involved in.

Category	No. Of Projects
Client	170
Consultant	130
Contractor	95
Total	395

Table 22: Number of projects

4.4.2 Variation Experience

Table 23 and Figure 7 indicate that all respondents have experienced Variation in a construction project.

Category	Yes	No
Client	20	
Consultant	26	
Contractor	19	
Total	65	

Table 23: Variation experience

4.4.3 Average Variation in terms of cost

The chart below indicated that 58% of the variations are less that 10% of the original contract value and 21% of the cost are between 10 to 30% of the contract value, 12 %

between 31% to 50%, 7% between 51% to 100% whereas only 2% is over 100 due to completely changing the scope of the project.

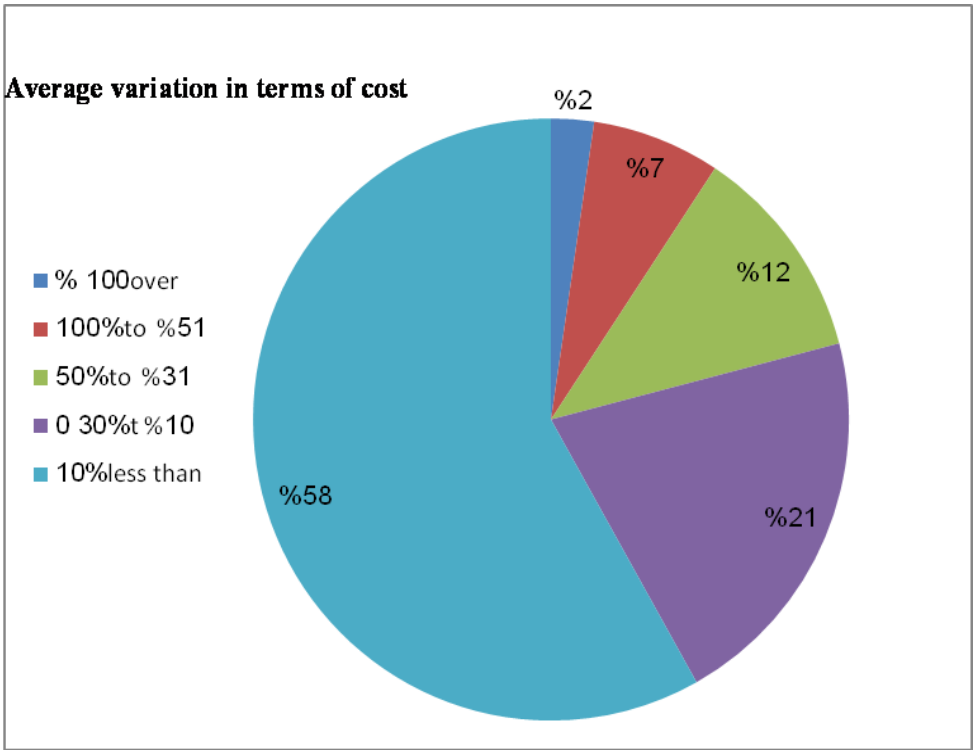


Figure 8: Average Variation in terms of cost

4.4.4 Average Percentage of Variation that were authorized

The graph below shows that 51% of participant is saying that variations get authorized by the client and 21% said that only 75% get authorized by the client whereas 14%, 9% and 5% respectively saying that variation get authorized by the client.

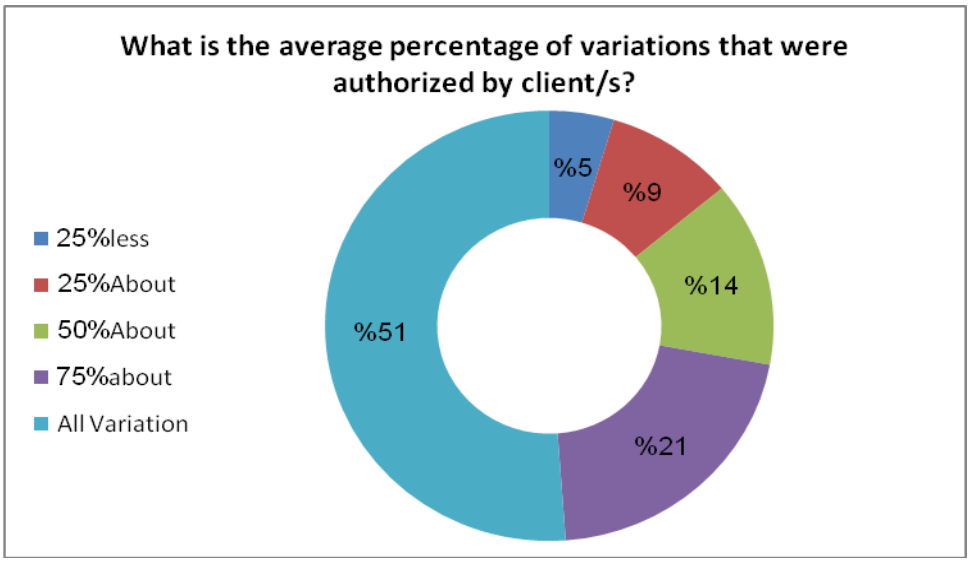


Figure 9: Average percentages of variations that were authorized by clients/s

4.4.5 Variation responsibility

Table 24 indicates that first party responsible for variation in the oil and gas projects is the client.

Category	Variation responsibility
Client	43
Consultant	9
Contractor	13

Table 24 Variation Responsibility

Figure 10 indicate that client is the first responsible party for variation in the oil and gas projects with 66% followed by contractor with 20% and the least is the consultant with 14%.

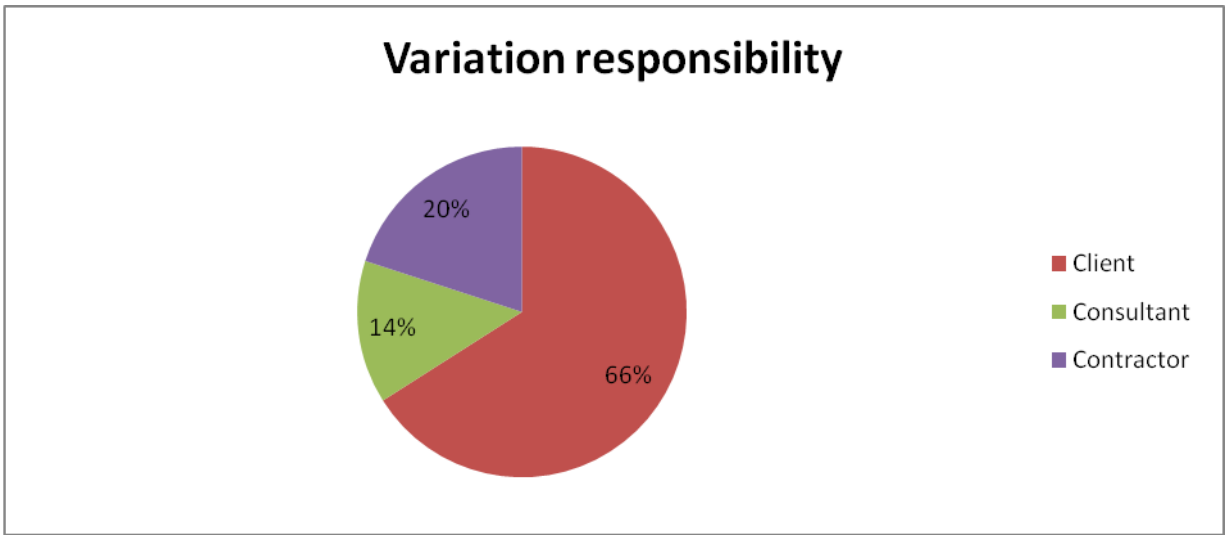


Figure 10: Variation responsibility

4.5 Variation Causes

Analysis of variation causes

4.5.1 Correlation

The ten bi-variate correlations with the highest (r) value and significant at the 1% level were identified and selected as follows:

1. Shortage of required materials with delay in Material delivery r=0.52**
2. Shortage of required materials with low skill of manpower r=0.40**
3. Failure of equipment with shortage of technical professionals in the contractor organization r=0.49**
4. Shortage of required equipment with ineffective contractor head office involvement in the project r=0.48**
5. Failure of equipment with delay in preparation of contractor submission r=0.434**
6. Shortage of required material with delay in the approval of contractor submissions by the consultant. r=0.40**
7. Delay in materials delivery with slow response from the consultant engineer to contractor inquiries. r=0.43**
8. Low skill of manpower with effects of social and cultural conditions r=0.40**
9. Shortage of manpower (skilled, semi-skilled and unskilled labor) with rise in prices of materials. r=0.40**
10. Poor controlling of subcontractors by contractor with ineffective control of project progress by the contractor=0.49**

Delay in materials delivery is associated with shortages of required material (Spearman r/o =0.52, Sig = 0.01) and when cross tabulated is significant (χ^2 =43.6, Sig = 0.000) as shown in Table 25.

Following recoding of the data as binary values (χ^2 =14.15, Sig= 0.000) it is found the with low delay in materials delivery 90% are related to low shortages of required materials as it is shown in Table 26.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.593[a]	9	.000
Likelihood Ratio	47.026	9	.000
Linear-by-Linear Association	15.409	1	.000
N of Valid Cases	65		

Table 25 a. 11 cells (68.8%) have expected count less than 5. The minimum expected count is .43.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	14.149[a]	1	.000		
Continuity Correction[b]	12.241	1	.000		
Likelihood Ratio	15.433	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	13.932	1	.000		
N of Valid Cases	65				

Table 26 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.15.

b. Computed only for a 2x2 table

Shortage of required materials is associated with low skill of manpower (Spearman r/o=0.40, Sig= 0.01 and when cross tabulated is significant at (χ^2 =,14.35 Sig = 0.112) as shown in Table 27.

Following recoding of the data as binary values (χ^2 =2.25, Sig= 0.13) it is found the with low delay in materials delivery 90% are related to low shortages of required materials as it is shown in Table 28.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.315[a]	9	.112
Likelihood Ratio	14.601	9	.102
Linear-by-Linear Association	10.352	1	.001
N of Valid Cases	65		

Table 27 a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is .86.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.245[a]	1	.134		
Continuity Correction[b]	1.514	1	.218		
Likelihood Ratio	2.308	1	.129		
Fisher's Exact Test				.183	.108
Linear-by-Linear Association	2.210	1	.137		
N of Valid Cases	65				

Table 28 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.80.

b. Computed only for a 2x2 table

Failure of equipment is associated with shortage of technical professionals in the contractor organization (Spearman r/o =0.49, Sig = 0.01) and when cross tabulated is significant at (χ^2 =22.501 Sig = 0.007) as shown in Table 29.

Following recoding of the data as binary values (χ^2 =22.50, Sig= 0.007) it is found the with low delay in materials delivery 90% are related to low shortages of required materials as it is shown in Table 30.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.501[a]	9	.007
Likelihood Ratio	24.607	9	.003
Linear-by-Linear Association	16.163	1	.000
N of Valid Cases	65		

Table 29 10 cells (62.5%) have expected count less than 5. The minimum expected count is .18.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.429[a]	1	.006		
Continuity Correction[b]	5.882	1	.015		
Likelihood Ratio	9.096	1	.003		
Fisher's Exact Test				.007	.005
Linear-by-Linear Association	7.315	1	.007		
N of Valid Cases	65				

Table 30 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.54.

b. Computed only for a 2x2 table

Shortage of required equipment is associated with ineffective contractor head office involvement in the project (Spearman r/o =0.480, Sig = 0.01) and when cross tabulated is significant at (χ^2 =29.64, Sig = 0.01) as shown in Table 31.

Following recoding of the data as binary values (χ^2 =29.64, Sig= 0.001) it is found the with low delay in materials delivery 90% are related to low shortages of required materials as it is shown in Table 32.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	29.644[a]	9	.001
Likelihood Ratio	29.696	9	.000
Linear-by-Linear Association	13.561	1	.000
N of Valid Cases	65		

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	29.644[a]	9	.001
Likelihood Ratio	29.696	9	.000
Linear-by-Linear Association	13.561	1	.000
N of Valid Cases	65		

Table 31 a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is .12.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	12.644[a]	1	.000		
Continuity Correction[b]	10.920	1	.001		
Likelihood Ratio	13.040	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	12.449	1	.000		
N of Valid Cases	65				

Table 32 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 12.92.

b. Computed only for a 2x2 table

Failure of equipment is associated with delay in preparation of contractor submission (Spearman = 0.434, Sig = 0.01) and when cross tabulated is significant at (χ^2 = 15.641, Sig = 0.075) as shown in Table 33.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.641[a]	9	.075
Likelihood Ratio	18.367	9	.031
Linear-by-Linear Association	11.687	1	.001
N of Valid Cases	65		

Table 33 a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is .06.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.624[a]	1	.003		
Continuity Correction[b]	7.058	1	.008		
Likelihood Ratio	8.723	1	.003		
Fisher's Exact Test				.005	.004
Linear-by-Linear Association	8.491	1	.004		
N of Valid Cases	65				

Table 34 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.75.

b. Computed only for a 2x2 table

Shortage of required material is associated with delay in the approval of contractor submission by the consultant (Spearman r/o = 0.405, Sig = 0.01) and when cross tabulated is significant at (χ^2 = 11.395, Sig = 0.250) as shown in Table 35.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.395[a]	9	.250
Likelihood Ratio	12.881	9	.168
Linear-by-Linear Association	.253	1	.615
N of Valid Cases	65		

Table 35 a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is .22.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11.609[a]	1	.001		
Continuity Correction[b]	9.890	1	.002		
Likelihood Ratio	12.343	1	.000		
Fisher's Exact Test				.001	.001
Linear-by-Linear Association	11.431	1	.001		
N of Valid Cases	65				

Table 36 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 10.49.

b. Computed only for a 2x2 table

Delay in material delivery is associated with slow response from the consultant engineer to contractor inquiries (Spearman r/o = 0.426, Sig = 0.001) and when cross-tabulated is significant at (χ^2 =23.194, Sig = 0.006) as shown in Table 37.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.194[a]	9	.006
Likelihood Ratio	25.354	9	.003
Linear-by-Linear Association	11.701	1	.001
N of Valid Cases	65		

Table 37 a. 11 cells (68.8%) have expected count less than 5. The minimum expected count is .62.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.850[a]	1	.016		
Continuity Correction[b]	4.705	1	.030		
Likelihood Ratio	5.961	1	.015		
Fisher's Exact Test				.024	.015
Linear-by-Linear Association	5.760	1	.016		
N of Valid Cases	65				

Table 38 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 13.85.

b. Computed only for a 2x2 table

Low skill of manpower is associated with effects of social and cultural conditions (Spearman r/o =0.406, Sig =.001) and when cross tabulated is significant at (χ^2 =17.332 Sig = 0.044) as shown in Table 39.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.332[a]	9	.044
Likelihood Ratio	18.941	9	.026
Linear-by-Linear Association	10.837	1	.001
N of Valid Cases	65		

Table 39a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is .12.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.815[a]	1	.028		
Continuity Correction[b]	3.686	1	.055		
Likelihood Ratio	4.772	1	.029		
Fisher's Exact Test				.053	.028
Linear-by-Linear Association	4.741	1	.029		
N of Valid Cases	65				

Table 40 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.00.

b. Computed only for a 2x2 table

Shortage of manpower (skilled, semi-skilled and unskilled) is associated with rise in prices of materials (Spearman r/o = 0.400, Sig) and when cross tabulated is significant at (χ^2 = 18.493, Sig = 0.026) as shown in Table 41.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.943[a]	9	.026
Likelihood Ratio	19.740	9	.020
Linear-by-Linear Association	1.949	1	.163
N of Valid Cases	65		

Table 41 a. 10 cells (62.5%) have expected count less than 5. The minimum expected count is .22.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.008[a]	1	.928		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.008	1	.928		
Fisher's Exact Test				1.000	.575
Linear-by-Linear Association	.008	1	.928		
N of Valid Cases	65				

Table 42 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.85.

b. Computed only for a 2x2 table

Poor controlling of subcontractor by contractor is associated with ineffective control of project progress by the contractor (Spearman r/o = 0.492, Sig = Sig = 0.01) and when cross tabulated is significant at (χ^2 = 25.407 Sig = 0.003) as shown in Table 43.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.407[a]	9	.003
Likelihood Ratio	28.454	9	.001
Linear-by-Linear Association	15.019	1	.000
N of Valid Cases	65		

Table 43 a. 9 cells (56.3%) have expected count less than 5. The minimum expected count is .37.

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11.274[a]	1	.001		
Continuity Correction[b]	9.581	1	.002		
Likelihood Ratio	11.385	1	.001		
Fisher's Exact Test				.001	.001
Linear-by-Linear Association	11.100	1	.001		
N of Valid Cases	65				

Table 44 a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.60.

4.5.2 T-Test

T-test of the means for two groups (N=45 Client and Consultant; N=20 Contractor) found significant variance (Levene's test for equality of variance) for 11 variables:

1. Changes in materials specification Sig=0.032, 0.484
2. Difficulties in financing the project by the contractor Sig=0.008, 0.020
3. Poor communication between the consultant engineer and other parties involved Sig=0.040, 0.504
4. Poor contract management Sig=0.002, 0.000
5. Unrealistic contract duration Sig=0.061, 0.131
6. Delay in progress payment by the client Sig=0.099, 0.573
7. Ambiguities, mistakes and inconsistencies in specifications and drawings Sig=0.031, 0.646
8. Original contract duration is too short Sig=0.018, 0.194
9. Difficulties in obtaining work permit Sig=0.065, 0.072
10. Government tendering system requirement of selecting the lowest bidding contractor Sig=0.059, 0.019
11. Severe weather condition Sig=0.019, 0.708

The means difference scores were significant at the 1% level; for 2/10 of these variables (2. Difficulties in financing the project by the contractor; and 4. Poor contract management)

4.5.3 One-Way ANOVA

	Item	1	2	3	F	Sig
	N	**19**	**26**	**20**		
1	Inadequate equipment used for the works.	1.95	1.81	2.45	3.641	0.032
2	Difficulties in financing the project by the contractor.	2.21	1.95	2.54	3.202	0.47
3	Poor coordination by the consultant engineer with other parties involved.	2.77	1.80	2.79	6.961	0.002
4	Poor Contract Management.	2.38	1.35	2.42	10.007	0.000
5	Interference by the client in the construction operations.	2.00	1.45	2.15	5.337	0.007
6	Client's poor communication with construction parties and government authorities.	2.00	1.73	2.45	3.788	0.028

Table 45: One-Way ANOVA

Table 45 shows six significant factors at 5% level ($p \leq .05$) of which only three are significant at the 1% level ($p \leq .01$) and should client, consultant and contractor focus on them in order to reduce and minimize variations in their project and these factors are the following poor coordination by the consultant engineer with other parties, poor contract management and interference by the client in the construction operations.

4.5.4 Rank Ordering of the Mean scores

	Items	Mean Score
1	Shortage of required equipments	2.34
2	Shortage of supporting and shoring installation for excavation	2.33
3	Changes in materials prices	2.32
4	Inadequate equipment used for the works	2.25
5	Shortage of required materials	2.25
6	Delay in furnishing and delivering the site to the contractor by client	2.22
7	Subsurface site condition materially differing from contract documents	2.20
8	Failure of equipment	2.20
9	Delay in materials delivery	2.18
10	Unrealistic contract duration	2.15

Table 46: Top 10 mean scores

Table 46 indicates that top of mean scores generated from SPSS, from 1-5 are the most critical factors have high possibility of causing variation and all of them related to materials and equipment which their score ranges from 2.25 to 2.34. The project manager should put more effort into them before construction start which means acting during the Front End

Engineering and Design (FEED) stage in order to put a clear plan for management of these factors to reduce the effect of these factors causing variation in the project. On the other hand factors from 6 – 10 fall in medium category with scores range from 2.15 to 2.22 causing less problems and the project manager may manage them by medium priority plan and through agreement with the construction contractor project manager.

	Items	Mean Score
1	Loose safety rules and regulation within the contractor organization	1.83
2	Delay in mobilization	1.83
3	Lack of motivation among contractor's members	1.83
4	Low skill of manpower	1.83
5	Shortage of technical professional in the contractor organization	1.82
6	Improper construction methods implemented by the contractor	1.82
7	In efficient quality control by contractor	1.80
8	Effect of subsurface condition(type of soil, utility lines, water table)	1.77
9	Ineffective control of project progress by contractor	1.75
10	Shortage of contractor's administrative personnel	1.69

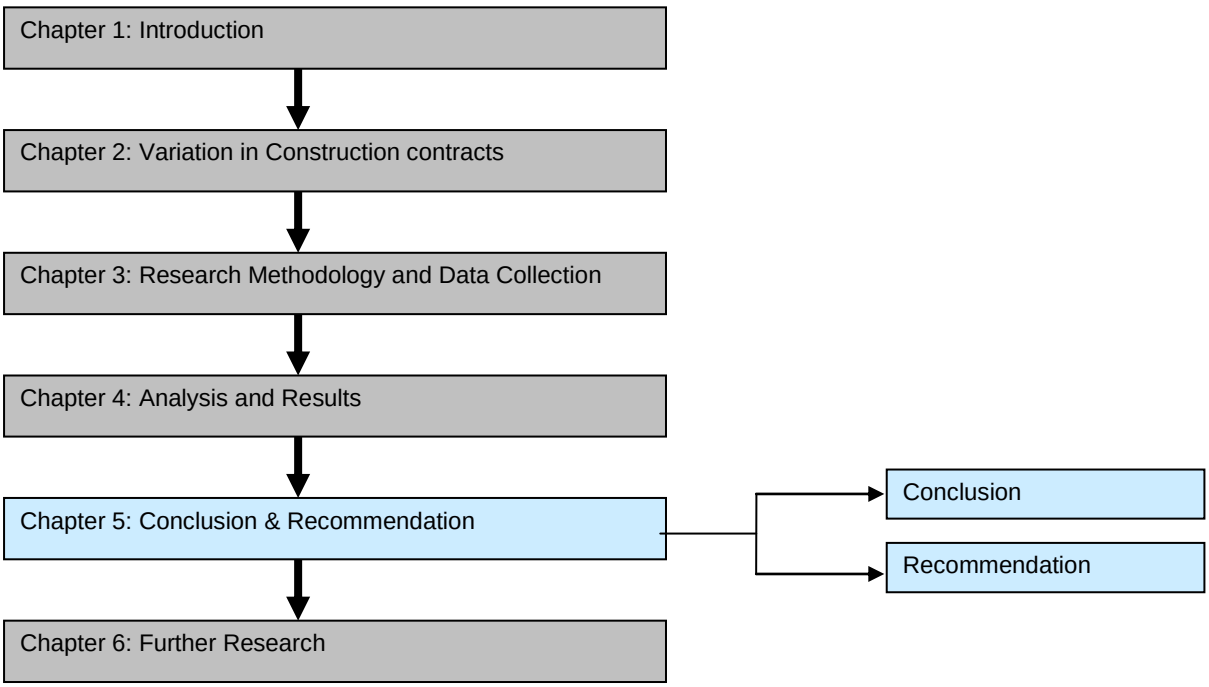
Table 47: Bottom 10 mean scores

Table 47 shows bottom 10 mean scores which fall in the lowest possibility of causing variation in the project and this may be managed by close coordination between all of the parties - client, consultant and contractor during construction.

Chapter 5

Conclusion and Recommendations

This chapter provides and discusses the major findings obtained from the previous chapter (Analysis and Results Chapter).



5.1 Conclusion

The causes of variation and their effects on project cost and schedule are complex and influenced by numerous interrelated factors. The risk and uncertainties associated with project changes make predictions and planning for changes a difficult task. The objective of this research study was to carry out a literature review and field survey to identify major causes of variations, their effects on projects and control procedures adopted in oil and gas projects in the UAE.

Based on the field survey conducted and result presented in Chapter 5 the following can be concluded:

1. The general industry information collected indicated the following facts: all professional parties involved in oil and gas project are large in size and most of them reported more than 10 years of experience. The common contract format is Oil and Gas project is the Engineering, Construction and Procurement (EPC) Lump Sum. The cost overrun due to variation orders is shown to be less than 10% of the original contract value in oil and gas projects. This value agrees with values indicated by some studies as discussed in the literature review.
2. The owner is the main source of changes in Oil & Gas projects. Change of plan by the owner is the main cause of variation. There are three possible explanations for 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 didn't understand or visualize the design. The designer may not have made the design clear or the owner just lack of ability to read the drawings. Third, it is merely a change of mind while at the same time not appreciating the negative impacts of changes. The result showed that changes can have a huge financial impact to the owner due to the huge value of the project which means 10% of change in cost can cost the client a considerable sum of money.
3. Substituting material and or procedure is the second source of changes order generated by the owner. This might be due to new material becoming available in the market or due to changes in specifications by the client and also due to delivery challenges.
4. The Contractor is the second major contributor to change due to site condition and design conflicts made by the consultant afterwards and/or error and omissions in the

design.

5. Increase in project cost and duration are the two main effects being noted for changes orders. Degradation of labor productivity and disputes scored low and are less prevalent.

5.2 Recommendations

Based on the findings of this research discussed in Chapter 5 together with the main conclusions listed above and referring to findings of previous studies discussed in the literature review, the following recommendations are now made:

As concluded earlier, the research indicates that the owner is major source of variation in Oil and Gas projects: 'Although the research showed that the owner gets involved during 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'.

(Source: http://faculty.kfupm.edu.sa/CEM/assaf/Students_Reports/Change-Orders-in-construction.doc). This recommendation re-iterates the same point made in previous research on variation order (change order) in construction. The extra effort made in understanding the design can minimize the changes that subsequently have to be made by the owner.

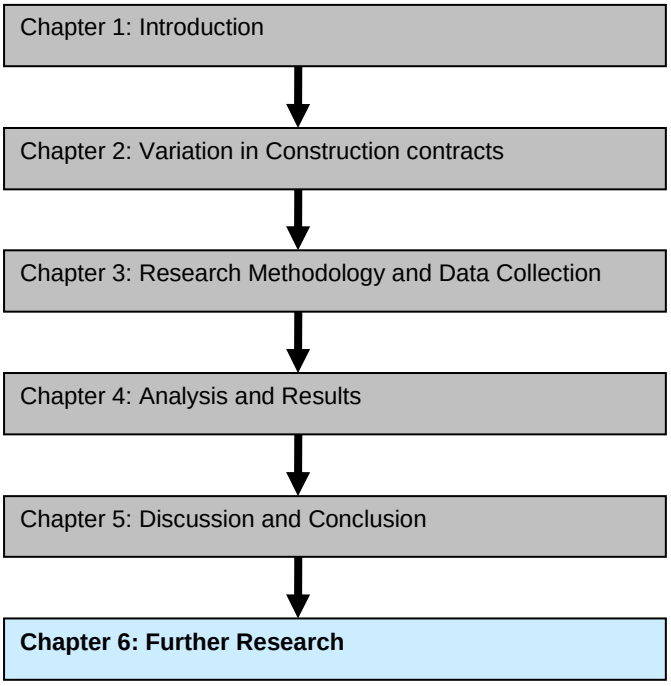
1. Owners should make adequate financial planning during planning stage to avoid changing plan later or during construction.

2. The project management consultant (PMC) and client should form an integrated team with the client in order to review the design as one team to understand the design and to ensure that the owner's needs and expectations are met.

3. The research showed that changes orders are thought of as additional revenue for the contractor. It is recommended that contractors educate their personnel on the negative impact of variation orders. In short changes should prove 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.

Chapter 6

Suggestions for Further Research



The study included three major participants in Oil and Gas projects, namely Client, Consultant and Contractor. As was mentioned in the conclusion, it is the owner who receives most of blame for generating changes. Few explanations are given as possible reasons. However following questions could be part of survey questionnaires in the future:

- 'Why does the owner make changes during construction?
- What could be done in the design stage to improve the owner understanding of the design drawings?
- Would owners prefer to see a model of their project before construction?
- Is there enough material specification to minimize the need for material substitution?'

As mentioned previously these questions for practitioners and researchers are identical to previous work on change order in construction.
(See: http://faculty.kfupm.edu.sa/CEM/assaf/Students_Reports/Change-Orders-in-construction.doc).

Since this study addresses the subject of variation for Oil and Gas projects, it would be interesting to study the subject of variation orders in other industrial construction projects and compare the results.

7 References

A

Al Maraz, J. (1994), '"Quality management and the Quality of Change'", *Jjournal of Organizational Change Management*, (7)2: 06-14.

Albert P.C Chan, Ada P.L Chan (2004), "Key performance indicator for measuring construction success", *International Journal of Project Management*, (11)2: 203-221.

Arian, F.M., and Pheng, L.S. (2005), '"The potential effects of variation orders on institutional building projects'", *Journal of Facilities*, (3)11/12: 496-510.

Aymen H. Al Momani A. H. (1996), "Construction cost prediction for public school building in Jordan", *Journal of Construction Management and Economics*, (14)4: 311-317.

B

Bourne, L., and Walker, D.H.T. (2005), '"The paradox of project control'", *Journal of Team Performance Management*, (11) 5/6: 157-178.

Bower D. (2000), "A systematic approach to the evaluation of indirect costs of contract variations", *Journal of Construction Management and Economics*, (18):263-268.

Burrows B. G, Seymour D. E., "The evaluation of change in construction industry", *The Journal of Construction Management and Economics*, (1)3: 199-215.

C

Carrillo, P. (2005), '"Lessons learned practices in the engineering, procurement and construction sector'", *Journal of Engineering, Construction and Architectural Management*, (12)3: 236-245.

Chan E H W, Suen H C H (2005), "Dispute resolution management for international construction projects in China", *Journal of Management Decision*, (43)4: 589-602.

Cornell, J. (1996), 'Aspects of the management of change'; *Journal of Management of Medicine*, (10)2: 23-30.

D

David H., Stephen D., and Mak, S. (2001), 'Risk Analysis in cost planning and its effects on efficiency in capital cost budgeting, *Journal of Logistics Information Management*, (14)5/6: 318-239.

Davis C.T., (2002), 'The Real Success Factor on Projects', *International Journal of Project Management*, (20)3, 185-190.

Duy L., Nguyen, O., Lan D. (2001), 'A study on project success factors in large construction projects in Vietnam', *Journal of Engineering, Construction and Architectural Management*, (11)6: 404-413.

H

Harphan A. (2005), 'Tools to manage continuing change: program and projects', *Journal of Development and Learning in Organizations*, (19)1: 15-16.

http://faculty.kfupm.edu.sa/CEM/assaf/Students_Reports/Change-Orders-in-construction.doc

http://hsc.csu.edu.au/pta/scansw/method.html

I

Ibbs C. W. (1997), 'Quantitative impacts of project change', *Journal of Construction Engineering and Management*, (123): 308-311.

Ibbs W., Wong C.K. and Kwak Y.H (2001), 'Project Change Management System', *Journal of Management in Engineering*, (17)3: 159-165.

Ireland, V. (1985) 'The role of managerial action in the cost, time and quality performance of high rise commercial building projects', *Journal of Construction* Management *and Economics*, (3)1: 59-87.

K

Kidd M. W., Thompson G. (2000), "Engineering design change management", *Journal of Integrated Manufacturing Systems*, (11)1: 74-77.

Koushki, P., Kkartam,N. (2004), 'Impact of construction material on project time and cost in Kuwait', *Journal of Engineering, Construction and Architectural Management*, (11)2: 126-132.

Kumaraswamy, M.(1996) Construction Disputes Minimization CIB Conference Vol.2 Spon.

M

Meckenna, N. (2005), '"Executing major projects through contractors'", *Massachusetts Institute of Technology*, URL: Http://hdl.handle.net/1721.1/31172.

Miller, H. (1998),"Variation and innovation and dynamic quality", *Journal of the TQM Magazine*, (10)6: 447-451.

www.Meed.com accessed on 22nd January, 2009.

N

Nicholas, M. (2005), "Executing major projects through contractors", Massachusetts Institute of Technology, URL: Http://hdl.handle.net/1721.1/31172.

P

Prico, A.D.F., and Chahal, K. (2000), 'A strategic framework for change management', *Journal of Construction Management and Economics*, (24)3: 237-251.

T

Taskinen T, and Smeds R (1999), 'Measuring change project management in manufacturing', *Iinternational Journal of Operation & Production Management*, (19)11: 1168-1186.

W

Waldersee, R., and Griffiths, A. (2004), 'Implement change: Matching implementation methods and change type', *Leadership and Organization Development Journal*, (25)5, 424-434.

Wu C.H., Hsieh T. Y, Cheng W. L., Shih Tong Lu S.T.(2004), 'Grey relation analysis of causes for change orders in highway construction', *Journal of Construction Management and Economics*, (22)5: 509-520.

X

Xiao H., and Prorerbs D. (2003), 'Factors influencing contractor performance: an international investigation', *Journal of Engineering, Construction and Architectural Management*, (10)5: 322-332.

Z

Zaneldin E.K. (2006) 'Construction claims in United Arab Emirates: Types, causes, and frequency', *International Journal of Project Management*, 24(5), 453-459.

Appendix A

Variation Orders in Oil & Gas Projects

This Survey is apart of the dissertation research for an MSc in project Management, by Ahmed Al Hammadi

The purpose of this study is to measure the frequency of occurrence, severity of impact, and importance of variation factors in oil & gas projects.

Please respond to the following questions either by ticking the appropriate box or by writing your answer in the space provided.
Please note:
• The answers should be based on your experience in oil & gas projects.
• All information provided will be treated in the strictest of confidence.

Section one – ***Questions related to the respondent's experience***.

1.1. What is your business?
□ Contractor
□ Consultant
□ Client/ Client representative
□ Other please specify _____

1.2. What sector do work in?
□ Public
□ Private
□ Both

1.3. How long have you been dealing with Oil & Gas projects?
□ <5 years
□ 5-10 years
□ 11-15 years
□ >15 years

1.5. **What is/are the size of project/s have you participated in?** (you might select more than one)
□ Very large (>1 Billion Dhs)
□ Large (Between 100 to 1 Billion Dhs.)
□ Medium (Between 10 to 100 Million)
□ Small (< 10 Million Dhs.)

Section two – ***Questions related to the contractual arrangements***

2.1. **What is/are the procurement method/s have you dealt with?** (you might select more than one)
□ Traditional
□ Unit rate
□ Design and build
□ Reimbursable
□ Other please specify_____

2.2. **What is/are the tendering arrangement/s have you experienced?** (you might select more than one)
□ Negotiation
□ Open tendering
□ Selective tendering
□ Two-stage selective tendering
□ Others please specify _____

Section three – ***Questions related to the performance of project/s you Have been involved in.***

3.1. How many Oil & Gas project have you participated in?
Please specify _____

3.2. Were there were any Variations in your project?
□ Yes
□ No

3.3. What percentage of your project had variations?
Please specify _____

3.4. What are the average variations in your project/s in terms of cost?
□ Less than 10%
□ 10 to 30 %
□ 31 to 50 %
□ 51 to 100%
□ Over 100 % please specify _____

3.5. What is the average percentage of variations that were authorized by client/s?
□ All variations
□ About 75% of variations
□ About 50 % of variations
□ About 25% of variations
□ Less than 25% of variations

Who is the first responsible of variation/s?
□ Contractor
□ Consultant
□ Clien

3.6. Please write down the most important 5 causes of variation of construction projects in order in your region? (see the causes of variations in section four)

Section four – ***Causes of variations***

4.1.Assess the following causes regarding to their frequency and severity weight.

The range of weighting in the research survey scaled from 1 to 4, as shown below:

Scale	Frequency	Severity
1	Never	None
2	Occasional	Fairly
3	Frequent	Severe
4	Continues	Very

Causes of Variations	Frequency	Severity
Contractor	Never Occasional Frequent Continues 1 2 3 4	None Fairly Severe Very 1 2 3 4
Materials		
1. Shortage of required Materials	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
2. Delay in materials Delivery	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
3. Changes in materials Prices	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
4. Changes in materials Specifications	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Equipment		
5. Shortage of required Equipment	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
6. Failure of equipment	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
7. Shortage of supporting and shoring installations for excavations	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
8. Inadequate equipment used for the works	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Manpower		
9. Shortage of manpower (skilled, semi-skilled, unskilled labour)	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
10. Low skill of manpower	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Project Management		
11. Lack of motivation among contractor's members	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
12. Shortage of contractor's administrative personnel	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
13. Shortage of technical professionals in the contractor' organization	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
14. Poor communications by the contractor with the parties	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐

involved in the project		
	Frequency	Severity
	Never Occasional Frequent Continues 1 2 3 4	None Fairly Severe Very 1 2 3 4
16. Slow preparation of changed orders requested by the contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
17. Ineffective contractor head office involvement in the project	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
18. Delays in mobilization	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
19. Poor controlling of subcontractors by contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
20. Loose safety rules and regulations within the contractor's organization	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
21. Poor qualifications of the contractor's technical staff assigned to the project	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
22. Improper technical studies by the contractor during the bidding stage	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
23. Ineffective planning and scheduling of the project by the contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
24. Delays to field survey by the contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
25. Ineffective control of project progress by the contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
26. Inefficient quality control by the contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
27. Delay in the preparation of contractor submissions	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
28. Improper construction methods implemented by the contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Project Finance		

29. Difficulties in financing the project by the contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
	Frequency	Severity
	Never Occasional Frequent Continues 1 2 3 4	None Fairly Severe Very 1 2 3 4
30. Cash flow problems faced by the contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
31. Problems between the contractor and his subcontractors with regard to payments	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Consultant		
32. Poor qualification of consultant engineer's staff assigned to the project	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
33. Delay in the preparation of drawings	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
34. Delay in the approval of contractor submissions by the consultant	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
35. Poor communication between the consultant engineer and other parties involved	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
36. Poor coordination by the consultant engineer with other parties involved	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
37. Delays in performing inspection and testing by the consultant engineer	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
38. Slow response from the consultant engineer to contractor inquiries	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
39. Inadequate design Specifications	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
40. Poor contract Management	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Client		
41. Delay in furnishing and delivering the site to the contractor by the client	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐

42. Unrealistic contract Duration	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
	Frequency	Severity
	Never Occasional Frequent Continues 1 2 3 4	None Fairly Severe Very 1 2 3 4
43. Delay in the settlement of contractor claims by the client	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
44. Suspension of work by the client's organization	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
45. Delay in issuing of change orders by the client	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
46. Slow decision making by the client's organization	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
47. Interference by the client in the construction operations	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
48. Uncooperative client with the contractor complicating contract Administration	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
49. Delay in progress payments by the client	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
50. Client's poor communication with the construction parties and government authorities	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
51. Client's failure to coordinate with government authorities during planning	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
52. Poor coordination by the client with the various parties during Construction	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
53. Excessive bureaucracy in the client's administration	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
Early Planning and design		
54. Changes in the scope of the project	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
55. Ambiguities, mistakes,	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐

and inconsistencies in specifications and drawings		
56. Subsurface site conditions materially differing from contract documents		
	Frequency	Severity
	Never Occasional Frequent Continues 1 2 3 4	None Fairly Severe Very 1 2 3 4
57. Original contract duration is too short		
Government Regulations		
58. Ineffective delay penalty	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
59. Difficulties in obtaining work permits	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
60. Government tendering system requirement of selecting the lowest bidding contractor	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
61. Changes in government regulations and laws	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
External Factors		
62. Severe weather conditions on the job site	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
63. Effects of subsurface conditions (type of soil, utility lines, water table)	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
64. Traffic control and restrictions on the job site	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
65. Effects of social and cultural conditions	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
66. Rise in the prices of materials	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
67. Work interference between various contractors	☐ ☐ ☐ ☐	☐ ☐ ☐ ☐

Appendix B

Dear sir/Madam

Subject: Survey

I am presently preparing a thesis on the variation order in oil and gas projects as part of my Master degree course in Project management.

An important element of this thesis is to carry out field survey to assess the causes of variation as actually experienced by construction parties.

Enclosed please find a questionnaire, and based on your experience as a professional in the field of oil and Gas projects, I kindly request you to spare part of your valuable time to fill it in. please not that your name and your company name will remain confidential as far as the results are concerned.

The collected data will be statistically analyzed, and a conclusion will be finalized. If you wish, I shall be happy to provide you with the result of the study once finished.

Your assistance and corporation will be highly appreciated

Thank you
Ahmed Al Hammadi

Appendix C

Problem Statement

A variation is any deviation from an agreed well-defined scope and schedule. Stated differently, this is a change in any modification to the contractual guidance provided to the contractor by the owner or owner's representative. This includes changes to plans, specifications or any other contract documents. A variation order is the formal document that is used to modify the original contractual agreement and becomes part of project's documents (Fisk, 1997; O'Brien, 1998). Furthermore, a variation order is a written order to the contractor signed by the owner and issued after execution of the contract, authorizing a change in the work or an adjustment in the contract sum or the contract time (Clough and Sears, 1994). As mentioned earlier, variations are inevitable in any construction project (Ibbs et al., 2001). Hence, in every construction project, a contingency sum is usually allocated to cater for possible variations in the project, while keeping the overall project cost intact. In this research I conduct a study within Oil & Gas development projects to examine how variations affect company business negatively as well as positively. So that my research will be limited to Oil & Gas development projects specified to the Abu Dhabi Company For Oil Onshore Operation. It will:

- Identify and examine the potential effects of variations in Oil & Gas major development/construction project.
    - Identify the types of changes within Oil & Gas development projects.
    - Identify cost impact to the overall Budget (Capex) incurred by Variation.
    - Identify affects of other operations in the company linked to the Projects.
    - Identify and examine if there are advantages to be gained by the company through implementing changes in the project.
    - Provide solutions and recommendations to reduce the adverse effects of variation orders for Oil & Gas Projects.

Appendix D

Secondary Document on Change Order

(www.faculty.kfupm.edu.ae)

Basics of Variations (Changes)

'Initially, the contractor receives the contract package in the form of plans, drawings, equipment lists and other documents. This constitutes the basics of his proposal. The contractor will calculate labor cost, material cost and schedule based on the original package. Obviously any change to this set of documents will alter his plan and calculations.

Changes can be initiated by all parties in the construction process. All changes, however, must be approved by the owner before implementation (CII publication 6-10 (1990) summarizes initiation of change orders as follows:

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

Changes can be classified in many different ways depending on the basis and the purpose of classifications. In this review, the most common classification will be presented. Changes in a construction project can be classified based on the cause that forced them (Burati, Farrington & Ledbetter 1992; Thomas and Napolitan 1994). The cause or originator based classification is best suited for the assessment of the cost impacts of changes. These causes can be numerous. In a study by Burati, et al., (1992), ‘deviation or changes in construction are caused by design, construction, fabrication, transportation or operability. Design changes, which were found to constitute 52.2% of total changes’, and fall mainly into three categories:

Design changes caused by improvement through design process (DCI (http://faculty.kfupm.edu.sa/CEM/assaf/Students_Reports/Change-Orders-in-

construction.doc). Examples are change resulting from design reviews, technological advances or constructability reviews.

1. Design changes originated by owner (DCO). Examples are scope changes.
2. Design changes are addition of pumps, valve or instrumentation that affect the operation of the facility."

Design errors and omissions mentioned in the study are also other possible causes of changes in construction. Hester et al (1991), summarizes the sources of changes from different studies. The lists show a consensus as to the sources of changes. Yu Kelving (1996) cites the owner's change of mind as the prime source of changes in residential housing projects.

Second, changes can classified in terms of net effect on scope (CII Publication 6-10 (1990), Fisk 1988) as follows:

- Additive change: this involves addition of work to the original scope (adding a new model for example).
- Deductive change: unlike the previous type this change involves deletion of work or shrinking the scope of work- contractors call this a negative change since it usually involves deduction in the contract value.
- Rework: due to quality deficiency. Although this type involves no scope change it could have a huge cost impact.
- Force majeure change: although this has the effect of a change, a force majeure caused change may entitle the contractor to schedule adjustment and (1) or cost adjustment depending on the condition of contract.

Third, changes can be classified by the procedure used to introduce them (CII publication 6-1- (1990); Fisk 1988; Cox 1997). This classification is important in discussing the legal aspects of changes.

1. Formal or directed change: a change introduced by the owner or his agent under the mechanism of the change clause.
2. Construction change: a change that resulted from a failure to do or not do on part of the owner's agent. This type is not initially documented as a change and hence becomes a potential source of dispute. The failure of the owner or owner's agent may take the form of error in design or drawings, wrong engineer interpretation of contract

documents, change in construction consequence imposed by a construction requirement etc. (Fisk 1988, Cox 1997).

3. Cardinal change: a change outside the scope of the contract and executed only after complete redefinition of the scope and re-negotiation of the contract. This can also be called a "scope Change". This is not necessarily a single change but can be the result of a number of changes that have the net effect of modifying the original scope.

A study by CII on effects of changes on labor productivity (Thomas and Napolitan 1994) present several other listing and classifications of change that show a great similarity. First changes are classified on the basis of the subject of change such as "changes to process design". In a second listing changes are classified in a form of a matrix showing type and originator third listing shows changes classified according to the account group responsible for the change (client, home office and field). Many of the listings, as noted by the CII report, are usually developed for the purpose of cost accounting and back charging and add little in clarifying the impacts of changes.

2.3 The legal aspect

In this regard, we refer to literature discussing legal aspects such as contract changes, clause interpretation, substantiation and management of claim. In this approach changes are looked at as a major source of construction claim and disputes. The major legal aspects are (CII publication 5-10-1986, Cox 1997):

- Selecting the best delivery system (contract format)
- Drafting and interpreting change clauses
- Documenting change order to be ready in case of litigation.

Most of these issues can be found in literature reviewing claims and disputes and dealing with after the fact approaches. However, there are few points that effect how a project will cope with changes and problems anticipated. As ascertained by Cox (1997), ‘an owner's management of change orders and claims must also anticipate and provide for dispute prevention and dispute resolution processes from the outset.’ (http://faculty.kfupm.edu.sa/CEM/assaf/Students_Reports/Change-Orders-in-construction.doc).

'There are numerous contract types used in construction depending on owner and project requirement. The most common types will be reviewed here.

Construction contract are typically drafted by the owner or his/her representative (consultant) and contain the subject matter and terms and conditions. The construction contract is typically compromises (Ashly & Workman, 1986):

- Bid form
- Agreement form
- General condition or standard specifications
- Special provisions
- Plans
- Addenda

Construction contract must also include a compensation system and generally are classified according to the compensation system as follows:

2.3.1 Fixed Priced Contracts

This category includes all contract types in which financial terms require the contractor to "establish a stipulated sum for the completion or execution of a defined quantity of work". (Ibbs et al., 1986). Under this category the following types are listed:

2.3.2 Lump Sum

The contractor in this type of contract is required to construct the project in accordance with plans and specification for a fixed sum. The contractor will be solely responsible for any cost exceeding the agreed amount. The scope may include or exclude materials, procurement or engineering as agreed.

The term Lump Sum Turn Key (LSTK) is often used to indicate a lump sum contract including design, procurement and construction. Sometimes it is referred to as simply a

turnkey contract. Another form of lump sum type contract used is the Lump Sum, Procure and Build (LSPB).

2.3.3 Unit Price

This contract type contains a detailed list of estimated work quantities such as cubic meters of excavated land or concrete or a total length of different pipe sizes. The owner in this case will take the risk of variation in quantity. Actual price paid (fixed) is determined by actual unit done as constructed. Unit Price contract allows the owner the freedom to make changes in the volume of work and permits more control (Ayers, 1988).'

2.3.4 Guaranteed Maximum

In this type of contracts the owner is guaranteed a maximum price for exceeding the work as defined in the contact. Normally the contact contains incentives clauses for cost under-run and penalty clauses for cost overruns. Ashly and Workman (1986) discussed the effects of incentives in the contract and concluded that they promote an attitude of motivation on the contractual relationship and take the form of inducements, encouragement and threats. The study also indicates that incentives are a tool used by owners to adjust the contract's fee. The study includes full details of finding on contractual motivation which is beyond the scope of this review.

According to Ayers (1998), about 90% of the contracts in construction are one form or another of fixed type contract. Ayers (1998), believes that fixed type contracts insures by competition that owners get the lowest price possible. Fixed type contract are, also characterized be well-defined scope and low risk for owners. According to Ayers (1998), the quality of work is usually poor.

2.3.5 Cost-Reimbursable Contract

This category includes all contract types, in which financial terms allow the contractor a price adjustment relative to project costs. Ibbs et al (1986) summarises the type of contracts which fall under this category as:

2.3.5.1 Cost Plus Fixed Fee

The contractor in this type of contract is paid whatever cost is associated with the project plus a lump sum fee for overhead and profit.

2.3.5.2 Cost Plus Percentage

In this type of contract the contractor is paid all costs associated with the project plus a percentage of these costs rather that a fixed sum or fee.

2.3.5.3 Target Price Plus a Fee

In this type of contract, a target price is first established for the cost of the project based on contract documents or unit prices. 'The contractor's fee will be based on this sum. Typically financial arrangements make provision for the contractor to share any savings below the target price or anticipated in the liability of cost overruns' Ayers(1998).

According to Ayers (1998), cost plus contract insure better quality at higher costs to owners. The block diagram below depicts the contract form division': (http://faculty.kfupm.edu.sa/CEM/assaf/Students_Reports/Change-Orders-in-construction.doc).

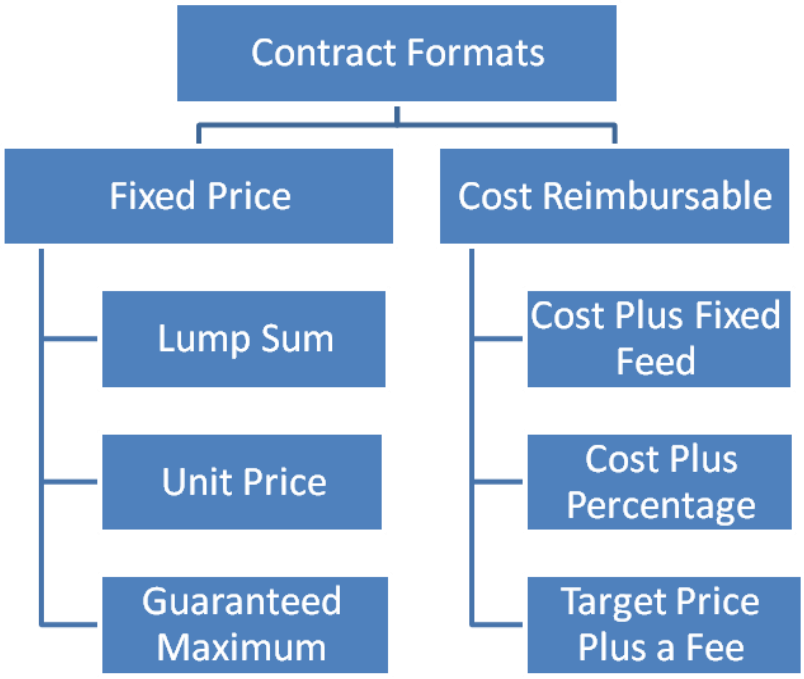


Figure 2 Contract form division

'There are other classifications or names used to describe certain contract formats based on scope or on contractual strategy such as the Engineer- Procure and construct contract (EPC) which is common in Oil and Gas Projects in the UAE. There is the Design and Build type (D&B) as discussed earlier. Other types include Build-Own-Operate-Transfer (BOOT) and Build-operate-Transfer (BOT) contract methods.

Webb (1995), studied the reward risk in partnership-based contract and highlighted that, 'A large number of different contract models and leasing arrangement are currently being used across the world, with the essential difference being the division and acceptance of risk by the different parties taking part in the structure'. The paper discussed the rising interest in concession contract arrangements which include arrangements such as BOOT and BOT 'even in the UK, concession contracts in the form of Design-Build-Finance-Operate (DBFO) projects are emerging as the fast track method for major road improvement' (Webb, 1995).

Ayers (1988) divides contracting strategies into single and partial. In single contracts, all the work is given to one single contractor. Partial contract is where more than one contractor is employed to do the work on a single project. Ayers (1988) also discussed the features of the single contract versus partial contract. Those features include level of control, level of required coordination and definition of contractor responsibilities.

Gilbreath (1992) divides contracting strategies into design-build, general contractor, few primes, multiple primes and force account. The feature of each was discussed and the author concluded 'only by thoroughly understanding the features and benefits of each approach can you (1) make a rational selection of any one approach over the other and (2) successfully implement the choice you have made.'

The very basic idea mentioned in Webb's paper about the division and acceptance of risk is what differentiates contract type or contractual arrangements and deserves close evaluation for every case to determine the suitable format and its level of accepted risk for the different parties. Ibbs et al (1986) indicated that "the choice of the type of contract (fixed cost versus cost reimbursable) should be heavily influenced by four circumstances:

- The extent to which the work is defined

- The desired allocation of risk between owner and contractor
- The availability of owner expertise and effort on the project
- The need to accommodate fast-tracking of design and construction
- The general marketplace condition.'

Ibbs et al (1986) summarized the commonly accepted ideas with respect to contract strategy as follows.

- Risk allocation is considered to be primarily directed toward the contract in fixed price contracts
- Risk allocation is considered to be primarily directed towards the owner in cost reimbursable contracts.
- More owner administrative time is required in cost reimbursable contracts
- Environment is less adversarial in cost plus contracts.
- Documentation and scope definition effort is more critical in fixed price contracts.
- Fixed price contracts provide less incentive for high quality work.
- Cost plus contracts provide more flexibility to change in design or scope.
- Cost reimbursable contracts assist in minimizing the schedule while fixed price contracts minimize costs.

Certainly not all types of contracts are equally sensitive to changes. If contracts are classified as either cost reimbursable or fixed price, the later with be the most sensitive to changes. For example, Resmond (1984) suggested that in a climate of intense competition, the winners of bid awards are not only willing to assume the risk of losing profit, but are also willing to improve their financial position through excessive use of change order. This premise was tested against a sample of actual data from the Western Division, USA Naval Facilities Engineering Commands.

In cost reimbursable projects there is a direct transfer of cost and schedule effects to the owner. Generally fixed price contracts are selected for projects in which the scope is well defined and the risk is low. Cost reimbursable contracts on the other hand are selected for ill-defined projects or for schedule acceleration'(http://faculty.kfupm.edu.sa/CEM/assaf/Students_Reports/Change-Orders-in-construction.doc). An interesting discussion on the degree of control required for each type of

contract is presented by Lock (1992). In short, the owner should consider changes when considering the type of contract for their project in terms of the liability of the contract to contain and minimize changes (cII publication 5-1, 1986).

The most important clause in this regard is the change clauses. ‘Change clauses are an important element of the contract because they provide mechanism for contract modification (either react to unexpected events or because the owner desire change) and for the appropriate compensation’ (CII publication 5-1, 1986). The change clause establishes the right of the owner to make changes within certain limitation and through a defined mechanism. As noted by Cox (1997), the change clause is ‘the most frequently relied on by contractors and subcontractor when seeking recovery of extra money.’

Krone (1992) found in his interesting comparison between construction management style in the US and Japan that change orders are uncommon in Japanese construction. Instead, Japanese contractors request additional money at the end of construction projects. In this study done by the Construction Industry Institute (CII publication 5-1, 1986) it was found that the changes clause is one of the most troublesome contract clauses. ‘Problems most often encountered with construction change clauses involved definition and negotiation of cost, dispute resolution and time required for approval.’ According to Hester (1991) legal disputes over changes often focus on whether or not there is a compensatory change exit, the appropriate level of compensation, and the relative responsibility for a change. Hester further differentiates between the direct and indirect impacts form of legal point of view. Two terms came into discussion namely compensability and exercisability of a change.

Krone (1991) conducted a study on a change order process that promoted efficient administrative performance and addresses the daily demands of changes in the construction process. The change order process has contributed to an increase in litigation and decline in production. The process can cause localized problems on a construction site to spread into other areas.'