KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DHAHRAN, SAUDI ARABIA

Construction Engineering & Management

CEM-520

CHANGE ORDERS IN CONSTRUCTION PROJECTS IN SAUDI ARABIA

BY

Abdulghafoor Habib Al-Dubaisi

Summarized By

Ali Al-Malki
Abdulwahid Al-Zahrani
Deyab Al-Jubran
Mohammed Al-Shammari

For

Dr.Sadi Assaf

May 26, 2007

TABLE OF CONTENTS

ABSTRACT

This research discusses the change order process in construction of large building projects in Saudi Arabia. The focus is on the causes of change orders, the impact of changes on a project, and the control procedures adopted. The subject is treated in two parts. The first part covers a review of literature discussing the subject of change orders. The second part is a field survey for over 34 contractor and consultant involved in construction and consultancy of large building projects.

The study attempts to establish a correlation between causes of change orders and the characteristics indicated in the first part. The research study shows that contractors and consultants agree to a large extent on the causes, effects, and controls of change orders.

1- INTRODUCTION

Saudi Arabia has in the last thirty years experienced a huge volume of work in the field of construction. This is because the wealth created by the oil industry and the economic impetus it has given the country. This has resulted in a very rapid grow and transformations during the period. Large and complex projects have been built, attracting contractors and construction companies from all over the world. Most of those contractors and their companies lack sufficient understanding of the social, cultural and physical environment of Saudi Arabia. This situation coupled with inexperienced owners led to inadequate design resulting in many changes to plans, specifications, and contract terms which we call it change order. A change 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.

These changes are inevitable in any construction project. Needs of the owner may change in the course of design or construction, market conditions may impose changes to the parameters of the project. All these factors and many others necessitate changes which are costly and generally un-welcomed by all parties.

Consideration must be given to this construction phenomena from the early stages of the project until commissioning. A procedure must be set to process a change from its conceptual development until it materializes in the field.

This study will assist both owners and contractors to plan effectively before starting a project and during the design phase to minimize and control changes and change effects. This study will also lay foundation for further research on the subject. The study will be limited to large building construction projects (projects costing over 50 million Saudi Riyals, SR. 3.75 = $1) in the Eastern Province of Saudi Arabia.

Objective

The main objectives of this research study are to:

- Identify the main causes of construction change orders in Saudi Arabia.
- Identify the severity of those causes.
- Test the hypothesis that consultants and contractors disagree on the severity of causes.

2- LITERATURE REVIEW

Introduction

This review is by no means a comprehensive one; it covers most important articles and subjects and can open the door for further research on the subject of changes.

The articles written on the subject of change orders deals with three aspects: legal, cost, and management. In this study, the literature review section is divided in four parts.

The first part defines the basics of changes and their terminology. The second part covers the legal aspects of changes in literature. The third part covers the evaluation and cost aspects and the fourth part concentrates on control, administration and procedures of changes.

Basics of Change

A change is 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 document. A change order is the formal document that is used to modify the original contractual agreement and becomes part of project's documents.

Changes in constructions are caused by design, construction, fabrication, transportation or constructions.

There are three categories for design changes:

1. Design changes caused by improvement through design process.
2. Design changes originated by owner.
3. Design changes initiated by Engineer or consultant.

Changes can be classified in terms of net effect on scope

1. Additive change. This involves addition of work to the original scope
2. Deductive change: Unlike the previous type this change involves deletion of work or shrinking the scope of work.
3. Rework - due to quality deficiency.
4. Force majeure change: A force majeure caused change may entitle the contractor to schedule adjustment and or cost adjustment depending on the conditions of contract.

Changes can be classified by the procedure used to introduce them

1. Formal or directed change: is a change introduced by the owner or his agent under the 1nechanism of the change clause.
2. Constructive Change: Is a change that resulted from a failure to do or not do on part of the owner or owner's agent.
3. Cardinal change is a change outside the scope of the contract and executed only after complete redefinition of the scope and renegotiation of the contract.

Legal Aspects

The major legal aspects are

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

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

The most important clause in this regard is the change clause: "Change clauses are an important element of the contract because they provide mechanism for contract modification and for appropriate compensation"

Cost Aspects

The cost impact of a change is greatly affected by the timing of the change. A change issued before construction has limited effects as compared to a change issued after construction has already started and material have been procured.

The impacts of a change are classified in the literature as follows:

1. Direct cost impact

The direct impacts are those limited to the work package in which a change is introduced. There are two components to the cost of a change, labor cost and material cost.

2. Direct schedule impact

It is easy to document a schedule impact of a change after change work is done, because all data is available regardless of its accuracy. However, it is difficult to predict impact of change on schedule before making a change because of the many uncertainties related to labor productivity, material availability or job interference3. Indirect or Consequential impact.

3. Indirect or consequential Impacts

There are always indirect impacts to changes that are often overlooked or underestimated. Consequential effects can occur later in other work packages and thus on total project.

<u>Costing of changes</u>

Costing of changes can become a real challenge on .a fixed price or lump sum contract.
On a cost plus, there is a direct transfer of cost to the owner and the problem does not exist.
The following procedures are used in costing changes

1. Price and schedule adjustment is negotiated prior to start of implementation.
2. If unit prices are part of the contract, they will be used as the basis of change work Pricing.
3. Contractor is directed to proceed with after the fact adjustment.

Management Aspects

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

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

Change Control

A change order control system should be established for the ultimate benefit of owners.

Changes to original scope and design are responsible for 50% of changes reported. Consequently if we can control the scope and define it well we can cut the amount of changes to a minimum.

The following actions will help in controlling changes:

1. Owner should define his needs and project objectives early in the project life.
2. Owner must be committed to change control.
3. A team effort by owner, Engineer and contractor to promote recognition, reporting and resolution of a change is required throughout the life of the project.
4. All changes must be justified from a cost point of view.

Change Scope Definition

The most important step in the development of a change order is the scope definition step.

Hence owner, owner representative and contractor have to be familiar with the facility, standards, and the contract when discussing a change scope.

Change Order Documentation

Since contractors usually have the required skills in each field that can participate in this development, most emphasis goes to the owner side. Owner should provide people who posses the following skills:

.

1. Negotiation skills
2. Estimating skills
3. Engineering design and layout skills
4. Communication skills.

The lack of these skills translate into poor change management and could cost the owner a fortune. Emphasis on this aspect is especially applicable to owners in our country dealing with more advanced and technically stronger foreign contractors.

3- CAUSES, EFFECTS AND CONTROLS

The study targets are defined in to three areas: causes, effects, and controls. The questionnaire will focus on these areas to view how they are treated by Saudi contractors and consultants.

Causes:

The potential causes of change orders in construction projects can be categorized mainly in to five main categories:

- By Owner which are:
    - Change of plans which are considered as the most significant cause in change.
    - Financial difficulties.
    - Change of schedule.
    - Poorly defined project objectives.
    - Change in design.
- By Contractor which are:
    - Substitution of Materials or Procedures.
    - The scope of work is not well defined.
    - Defective workmanship.
    - Unavailability of equipment.
    - Unavailability of skills.
    - Financial difficulties.
- By Designer or Consultant which are:
    - Conflict between contract documents.
    - Errors and omissions in design.
    - Safety considerations that were over looked.
- By all three combined which are:
    - Lack of coordination between parties.
    - Value engineering that was not considered.
    - New technologies that would be applied.
- By an outside reason which are:
    - Differing site conditions.
    - New government regulations.

Effects

Common effects that are mostly encountered can be divided in to four fields that are affected by change:

- Effects on efficiency that can lead to:
    - Decrease in productivity.
    - Decrease in quality.
- Effects on time that can lead to:
    - Delay in completing schedule.
    - Delay of materials and tools.
    - Hold on work.
    - Delay in payment.
- Effects on cost that can lead to:
    - Increase in project cost.
    - Additional money for contractor.
    - Increase in overhead expenses.
    - Demolition and re-work.
- Effects on the relations between owner and contractor that can lead to dispute and legal actions that can also lead to the above results.

Controls

Common control procedures used to minimize the effects of change orders are discussed in this section which can be summarized to:

- Conducting efficient change order procedures by clarifying change order procedure, defining a change order scope, justifying changes, and negotiating them to reach successful agreement.
- Effective planning of change orders by reviewing contract documents thoroughly and freezing design if necessary.
- Following legal and formal procedure in conducting a change order by expediting Approvals which are at their best if in Writing.
- Assessing changes by pricing indirect effects and continuously administrating changes by using the Work Breakdown Structure.
- Implementing team work and effort that can lead to high levels of cooperation.

4- SURVEY QUESTIONAIRE

Preparation:

Objectives of the study were taken care of in the questionnaire. Brainstorming, Meetings with the industry people, and phrasing the questions in an easy language were considered to put the right questions in a clear and understandable way. An Arabic version of the questionnaire was written to those participants that does not speak English.

Contents:

The questionnaire is divided into six sections.

1. Instructions on how to answer questions.
2. General information about the participants and their firms.
3. General industry characteristics related to changes.

Questions in sections two and three are in multiple choice formats.

4. Causes leading to change orders.
5. Possible effects of change orders.
6. Controls of changes and how to manage and minimize their impact.

Responses were given a 5- point scale starting with "VERY OFTEN" and ending with "NEVER" to answer questions in sections four, five, and six.

Sample Restrictions:

Four restrictions were imposed:

1. Large projects (20 million SR or more)
2. Large contractors (grade 2 or better)
3. Building projects
4. Eastern Province of Saudi Arabia

Total qualified participants were 42 contractors and 41 consultants.

Sample Size:

Using statistical principles, the following equations were used to calculate the minimum sample required:

$$n_o = (p * q) / V^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$n = n_o / [1 + (n_o / N)] \ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where:

- n_0 : First estimate of sample size
- p : The proportion of the characteristic (0.5)
- q : Compliment of 'p' or I-p
- V : The maximum standard error allowed (10% or 0.1)
- N : The population size (42 contractors & 41 consultants)
- n : The sample size

Minimum required sample after solving the equations are 15.67 for contractors and 15.53 for consultants. For real life, 16 samples of both should be chosen.

Data Gathered:

37 responses were received as follows:

- 20 contractors (47%).
- 17 consultants (41%).

To maintain a 1:1 ratio, 17 responses were chosen for both.

Scoring:

Ordinal scale was used in the scoring method. It is transformed into an interval scale by assigning a weight to each interval to provide a direct quantitative comparison between intervals.

The interval from 'never' to 'very often' is set as an interval from zero to 100.

Sections IV, V, and VI on causes, effects, and controls respectively will be scored as follows:

- 'VERY OFTEN'= (100%),
- 'OFTEN'= (75%),
- 'SOMETIMES'= (50%),
- 'SELDOM'= (25%),
- 'NEVER'= (0%)

Importance Index, Prevalence Index, and Utilization Index of each cause, effect and control respectively will be calculated from the following equation:

$$II_{c1} = \left(100x_1 + 75x_2 + 50x_3 + 25x_4 + 0x_5\right) / \left(x_1 + x_2 + x_3 + x_4 + x_5\right)$$

Where:

II: Importance index (C1 denotes cause 1 in this case)

x_1: Number of respondents answering (VERY OFTEN)

x_2: Number of respondents answering (OFTEN)

x_3: Number of respondents answering (SOMETIMES)

x_4: Number of respondents answering (SELDOM)

x_5, Number of respondents answering (NEVER)

Prevalence and Utilization Indices will be calculated in the same way.

5- RESULTS AND FINDINGS

The discussion of the results from the sections on general information

The general information section contains information on the size and level of experience of the contractors and consultants in the field of large building construction in Saudi Arabia.
Contractors are larger in size (number of employees) than consultants. Most consultants companies (70%) are less than 200 employees whereas only 35% of the contractors are smaller than 200 employees. None of the contractors and consultants participated in the survey has experience of less than 5 years.

Figure 5.1.5, shows the distribution of contractors and consultants over the type of construction contract format. *65%* of respondents said that construction contracts of their projects are lump sum turnkey type. 18% indicated that construction contracts of their projects are lump sum excluding material. None of the respondents reported design and build (D&B) type contract.

Figure 5.1.5 : Distribution of type of contract in large building projects

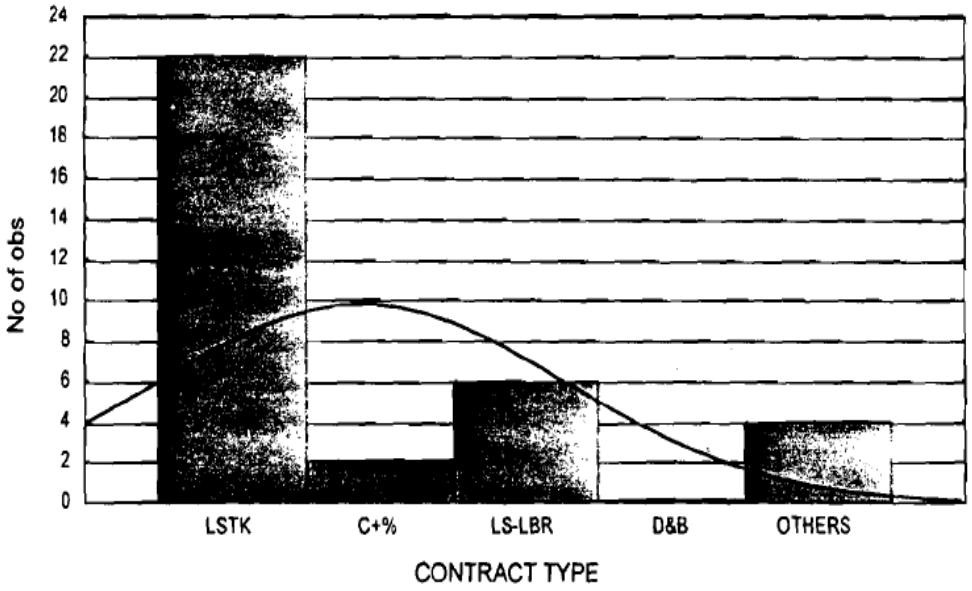


Figure 5.1.9 shows the histogram of the percent increase in project cost due to change orders. Over 50% of both contractors and consultants said the percent increase due to change orders is 6 to 10% of total project cost. 26% said the percentage is 11 to 15%.

Figure 5.1.9 : Distribution of % increase in cost due to changes

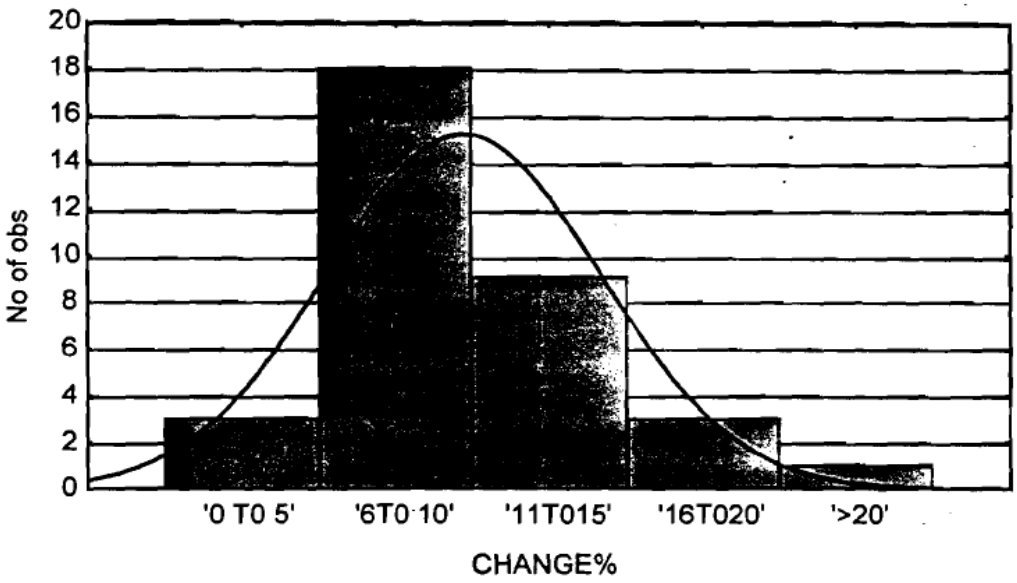
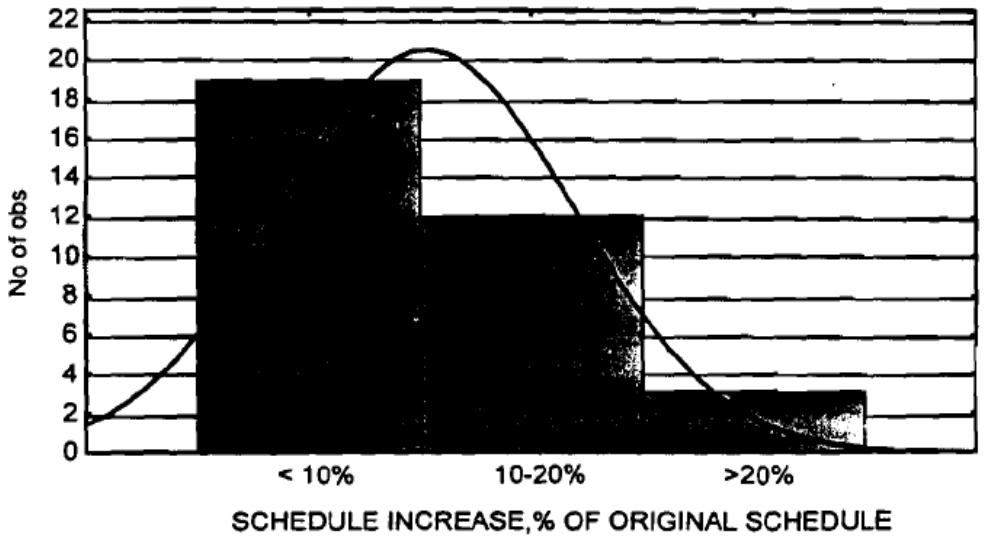


Figure 5.1.10 shows the percent increase in schedule due to change orders. Over 55% of the contractors and consultants said the percent increase is less than 10% of the original schedule. 35% said the schedule overrun is between 10 and 20% of original schedule. Less than one percent said the increase is more than 20%.

Figure 5.1.10 : Distribution of % increase in scedule due to changes



Causes of Change Orders

The causes of change orders are discussed by examined the data provided by three different perspectives: Contractors, consultants and combination of both and all of the results of responses of all of them on the causes of change order are listed below.

Contractors only

1. Change of plan by owner
2. Owner financial problem
3. Owner change of schedule
4. The objective of project is not well define
5. Substitution of materials or product
6. Conflict between contact documents
7. Change in design by consultant
8. The scope of work for the contractor is not well defined
9. Errors and omissions in design
10. The lack of coordination between
11. Contractor and consultant
12. Value engineering
13. Technology changes
14. Contractor desire to improve his financial situation
15. The contractor financial difficulties
16. The required labor skills are not available
17. The required equipment and tools are not available
18. Workmanship or material not meeting the specifications
19. Safety consideration
20. Weather conditions
21. New government regulations

The five most common causes of change orders from the contractor's point of view are listed (starting from the most important):
1. Change of plans by owner
2. Errors and omissions in design
3. Change in design by consultant
4. Substitution of materials or procedures.
5. Owner's financial problems and conflict between contract documents.

Consultants only

Similar to contractor causes are used for consultants and the five most common causes of change orders from the Consultants point of view are listed (starting from the most important):
1. Change of plans by owner
2. Substitution of materials or procedures
3. Owner's financial problems
4. Owner change of schedule
5. Lack of coordination between contractor and consultant.

Contractors and Consultants

The overall ranking of the top five causes of causes among all contractors and consultants is as follows:
1. Change of plans by owner
2. Substitution of materials and procedures
3. Errors and omissions in design
4. Owner financial problems
5. Change in design by consultant

Then, both contractors and consultants believe that owner is the major source of changes in large building projects.

Effects of Change Orders

The Effects of change orders are discussed by examined the data provided by three different perspectives: Contractors, consultants and combination of both and all of the results of responses of all of them on the Effects of change order are listed below:

1) Decrease in productivity
2) Delay in completion schedule
3) Dispute between owner and contractor
4) Decrease in quality of work
5) Increase in project cost
6) Additional revenue for contractor
7) Delay of material and tools
8) Hold on work in other areas
9) Increase in contractor's overhead
10) Delay in payment to contractor
11) Demolition and re-work

Contractors only

From contractors' point of view, the top five effects (prevalence) of change orders in their large building projects listed in descending order are:
1. Delay in completion schedule
2. Increase in project cost
3. Increase in contractor's overhead
4. Decrease in productivity of workers
5. Additional revenue for contractors

Consultants only

Similar to contractor effects are used for consultants and the five most common effects of change orders from the Consultants point of view are listed (starting from the most important):
1. Increase in project cost
2. Delay in completion schedule
3. Additional revenue for contractors
4. Dispute between contractors and owners
5. Demolition and re-work

Contractors and Consultants

The overall ranking of the top five effects of causes among all contractors and consultants is as follows:
1. Increase in project cost
2. Delay in completion schedule
3. Additional revenue for contractors
4. Demolition and re-work
5. Increase in contractor's overhead

Controls of Change Orders

The responses from contractors, consultants, and the overall responses on the controls of change orders in the large building construction in Saudi Arabia are studied.
Index for Controls of Change Orders for Contractor, consultants and combination.

1) Early setting of change order handling procedures
2) Timely approval of change order
3) Negotiation by knowledgeable people
4) Appropriate approval in writing
5) Clarity of scope of change
6) Giving consideration to indirect effects in change order pricing
7) Checking and review of design changes for feasibility
8) Review of gray areas in contract documents
9) Freeze of design
10) Team effort between parties
11) Work-break down structure

Results of analysis are highlighted in the following figures (next page) for each case:

Figure 5.4.1 : Utilization Indexes of controls-Contractors

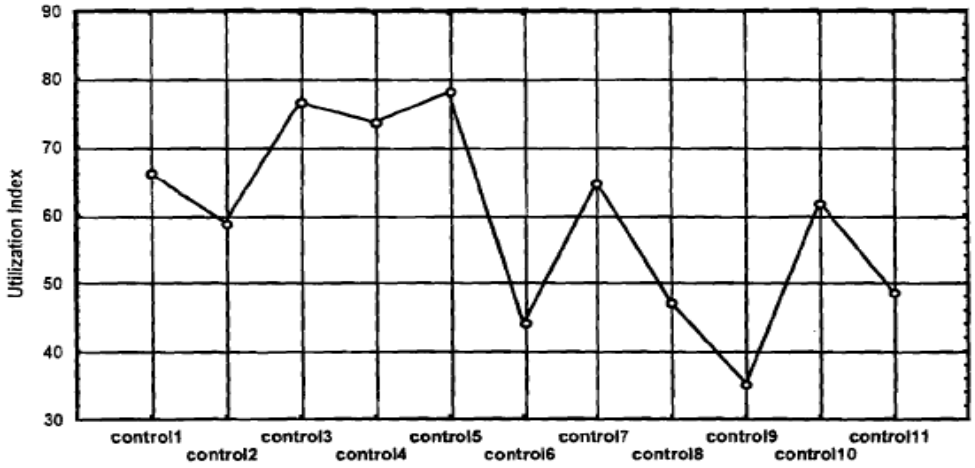


Figure 5.4.2 : Utilization Indexes of controls-Consultants

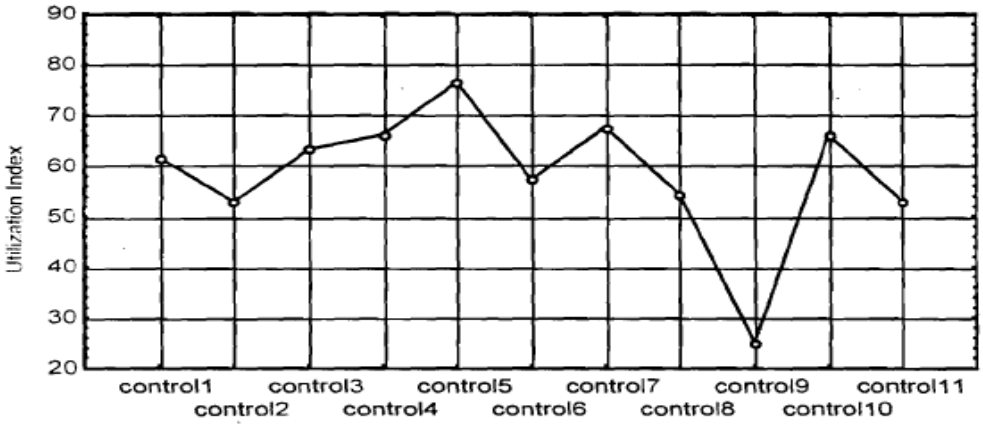
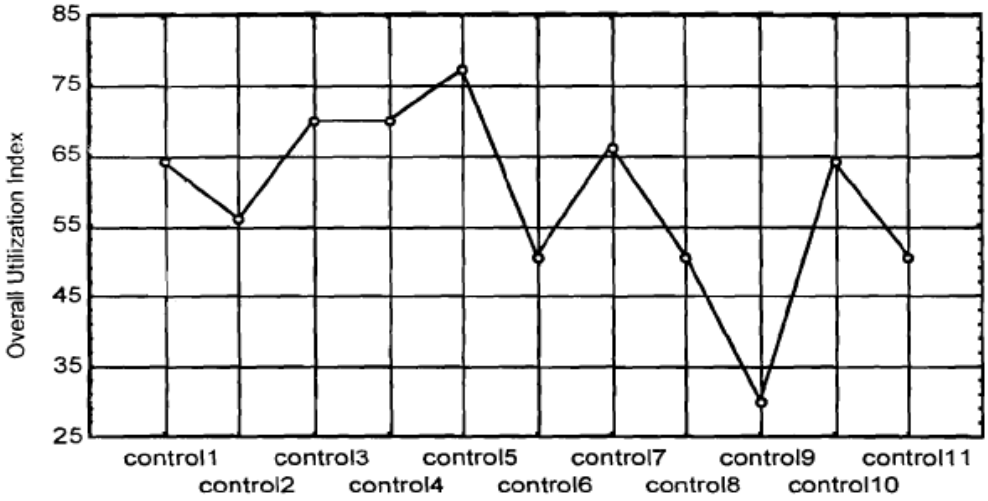


Figure 5.4.3 : Utilization Index of controls-Overall



Correlation and Hypothesis Testing

Correlation exists between the amount of change order generated and company size, owner involvement, years of experience, relation of principal parties, amount of increase in schedule and use of controls are studied in this chapter.

The hypothesis testing is used by using T-test statistics and the same hypothesis testing technique is used to test for contractors - consultant's agreement or disagreement on the prevalence of effects and the utilization of controls.

The conclusion is that correlation calculations failed to prove any relation between the variables considered and the percent increase in project cost due to change orders.

Finally, test for the degree of agreement or disagreement between the consultants and contractors on the causes, effects, and controls of change orders were carried out. As conclusion the following outcome are listed: Contractors and consultants do agree on the causes of change orders, Contractors and consultants do agree on the effects of change orders and Contractors and consultants do agree on the controls of change orders.

6- CONCLUSION AND RECOMMENDATIONS

Conclusion

The causes of change orders, and their effects on projects 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 a literature review and field survey to identify major causes of changes, their effects on projects, and adopted control procedures in large building projects in Saudi Arabia.

The research tested the level of agreement between contractors and consultants over the causes, effects, and controls and found a large degree of agreement. The research showed that most contractors involved in large building projects are large companies with over 500 employees and long construction experience of over 15 years. This indicates well established and stable sectors. The research showed also that over 60% of changes are civil or architectural in nature.

The research indicates that owner is the major cause of change orders in large building projects. Increase of project cost and schedule are the main effects as expected. Clarity of scope of work is the most utilized control against change order problems. The research showed that contractors and consultants agree to a large extent on the causes of change orders, effects of these changes and the controls adopted. This is contrary to the common perception that consultants and contractors would not agree.

Recommendations

Based on the findings of this research study and the literature search, the following recommendations are made:

1- The research indicates that owner is the major source of change orders in large building construction. As gathered from many field interviews, owner normally lacks the ability of reading design documents prepared by the Engineer. As the research showed that most changes are architectural, three-dimension model is very helpful in this regard and shall be used to help owners see their project before construction starts. Another justified recommendation is to get a project management consultant firm (PMC) to supervise both the design and construction activities to insure that owners need and expectations are met by the design.

2- Substitution of materials or procedures came as the second source of change orders and normally originated by owner. It is recommended to have the Engineer to specify the material for the building in a detailed manner to eliminate the possibility of changes later.

3- The research showed that change orders are thought of as additional revenue for contractor. It is recommended that contractors educate their personnel on the negative effects of change orders.

4- The utilization for the review of contract documents is very low. Contractors should expend more effort prior to contract award to review contract document.

5- Contractors should consider using Work Breakdown Structure or other tracking system more often than it used now. Many contractors indicate they are not using any type of structuring system for their construction activities and this may lead to inability to tracing effects of change orders on rest of the project.

7- CRITIQUE

The thesis was summarized as per to the researcher's layout and no change in the design of the thesis and formation of it was changed although there are some issues that we did not agree with the researcher on.

Critique:

- The moral and psychological effects were not mentioned in the causes' part while they are very important since they are directly related to honesty and professionalism in conducting construction procedures and regulations.
- Some of the causes and effects are closely related to or dependent on each other in such a way that they could have been mentioned together or even not mentioned at all.
- Restrictions were imposed on the participants in the questionnaire. A question rises whether the investigation in causes, effects, and controls were made with the same restrictions or not.
- The calculation resulted in choosing 16 samples of contractors and consultants and the researcher decided to choose 17. That is in our opinion not based on accurate procedure.
- Sending the questionnaire to participants is not enough in our opinion. Since all are busy contractors and consultants, answering the questionnaire could have been done in a quick matter. It would have been better if the questionnaire was filled by the researcher while conducting a meeting with the participant.
- On page # 83

  1- Title is written as case (a) for consultant only and the correct is case (b) .

  2- Table 5.2.3 Importance indexes of causes-Contractor view and the correct is Consultants NOT contractor.
- On page # 101

  In second paragraph research writer said for test the hypothesis that ' contractors and consultants do not agree on the causes of change orders' by comparing the population means where the analysis shows they DO AGREE as explained in Fig. 5.5.10.