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**CHANGE ORDERS IN CONSTRUCTION
PROJECTS IN SAUDI ARABIA**



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ABSTRACT

This paper presents a study made on causes, effects and controls of change orders in large building construction in Saudi Arabia. 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 change orders. In light of the literature study the researcher developed a survey questionnaire.

The questionnaire was distributed to all building contractors, grade1 and 2 registered with the eastern province of commerce as well as building consultant. The first included questions on the general market characteristics and general trends. The second included questions on the possible causes of change orders. The third included question on the possible outcomes of changes. The fourth included questions on the management control tools utilized for minimizing the problems of change orders.

Response from 34 consultants and contractors working in the field of large building construction were analyzed. Analysis of data indicated that cost overruns due to change orders were in magnitude of 6 to 10% of the original contract value. Schedule overrun was reported less than 10% of the original contract duration. The study also concluded that the owner is the major source of changes and that most changes are architectural. Change of plans and material substitution are first causes of change in large buildings.

The study also concluded that responses from contractors and consultants agree about the causes, effects and controls of change orders and recommended to include the owner in future studies to verify the reasons behind changes made by the owners

CHAPTER 1: INTRODUCTION

Saudi Arabia in the last thirty years experienced a huge volume of work in the field of constructions. This is resulted in very rapid growth and transformations during that period. The high living standard of people of Saudi Arabia have generated many manufacturing and building opportunities. The growth of towns has accelerated as a result of high population growth. Large and complex projects have been built, attracting contractors and construction companies from all over the world. This situation coupled with inexperienced owners has led to inadequate design resulting in many changes to plans, specifications, and contract terms.

Consideration must be given to this construction phenomena from the early stages of the project until commissioning. A contract change is added to define the way that owner, consultant, and contractors will handle changes. A procedure must be set to process a change from its conceptual development until it materialized in the field. Given the fact that an adversarial atmosphere usually exists between the parties in construction industry, a change must be managed well in order to minimize its cost, schedule and consequential effects that can lead to enormous cost and schedule overruns.

Objectives

The main objectives of this research study are to:

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

Limitation

The study will be limited to large building construction project (project costing over SR 20 millions) in the eastern province of Saudi Arabia executed by building contractors Grade 1 and Grade 2 as classified by chamber of commerce in Dammam. Grade one contractors are joint venture companies and Saudi companies with a working capital of more than SR 10 millions. Grade two contractors are Saudi contractors with working capital of more than SR 5 millions.

CHAPTER 2: LITERATURE REVIEW

In this study the literature review section is divided into 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 aspect and the fourth part concentrates on control, administration and procedures of changes

2.1 Basic of change

A change is defined in literature as any deviation from an agreed upon well-defined scope and schedule. Stated differently a change is any modification to the contractual guidance provided to the contractor by the owner or owner's representative. CII Publication 6-10(1990) summarizes initiation of change orders as follows:

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

Previous studies categorized design changes mainly into:

- Design changes caused by improvement through design process. Examples are changes resulting from design reviews and technological changes.
- Design changes originated by owner. Examples are scope of work.
- Design changes initiated by Engineer or consultant .Example addition of pump

Changes can be classified in terms of net effect on scope as follows:

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

Third, changes can be classified by the procedure used to introduce them:

- Formal or direct change: a change introduced by the owner or his agent under the mechanism of change clause.
- Constructive change: change that resulted from the a failure in the design
- Cordial change: a change outside the scope of the contract and executed only after complete redefinition of the scope and re negotiation of the contract.

2.2 The Legal Aspects

a) Selecting the delivery system,

The choice of the type of contract (fixed cost versus cost reimbursable) should be heavily influence by some circumstances like the extent to which work is defined, the desired allocation of risk between owner and contractor, the availability of owner expertise and effort on the project, fast-tracking or not and the general marketplace conditions.

Certainly not all type of contract is equally sensitive to changes as fixed cost type of contracts will be the most sensitive to changes.

b) Drafting and interpreting change clauses

It defined how the two parties will handle changes and change orders and form the basis of any legal claims. The finding suggests that the change clause of the general conditions should emphasize early proposal pricing. Some times owner or an engineer may attempt to avoid responsibility for changes by using disclaimer clause or risk shifting clause in the contract.

c) Documenting change orders to be ready in case of litigation.

2.3 Cost Aspect

The literature published can be classified as either qualitative or quantities. Qualitative studies discuss the various attributes of cost and schedule impact without quantifying them. Quantative studies on the other hand attempt to quantify the various attributes of cost and schedule impacts. The impact of a change are classified in the literature as follows

2.3.1 Direct cost impact

The direct cost impacts are those limited to the work package in which a change is introduced. There are two components to the cost of change: labor and material cost. Material cost is easy to estimate and predict to certain accuracy. However it is difficult to estimate labor cost due to:

- The effect of changes on the productivity rate itself.
- The uncertainty about the scope of a change.

Labor cost of changes can be broken into three attributes

- a) Productivity degradation (Human factor)
- b) Cost of delay
- c) Demolition and rework:

Changes, which are introduced when the construction is underway or even complete, involve several direct cost items, which can be summarized as follows:

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

2.3.2 Direct schedule impact

2.3.3 Indirect or Consequential Impacts

The following are among the possible consequential effects

- a) Effects on the methods or procedures used in other work packages due to a change in a previous task or package
- b) Degradation of productivity in subsequent packages or activity
- c) Increase in overhead cost
- d) Impact on subcontractors
- e) Miscellaneous: the following are some potential cost items that may be overlooked

2.3.5 Costing of changes

The following procedures are used in costing changes:

- a) Price and schedule adjustment are negotiated prior to the start of implementation.
- b) If unit prices are part of the contract, they will be used as the basis of change work pricing.
- c) The contractor is directed to proceed with after the fact adjustment.

The first technique is in wide use in the construction industry. However, it requires a commitment from both parties to expedite and carry change procedure in an open and trustworthy environment.

2.4 Management Aspects

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

The changes impact task force of the construction industry institute prepared a checklist of the most common parameters to consider when considering change .These parameters were classified under different categories like:

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

2.4.1 Change control

A change order control system should be established for the ultimate benefit of owners. Some actions could help in controlling changes as follows:

- The owner should define his needs and project objectives easily in the project life. Design scoping paper or the conceptual development should be as clear as possible.
- The owner must be committed to change control .The owner may consider forming a change review committee which includes owner's project engineer ,Business manager and process engineer to carry out the owner's commitment to reduce change effects.
- A team effort by owner, engineer and contractors to promote recognition ,reporting ,and resolution of a change is required throughout the life of the project
- Freezing the design is a strong control method
- All changes must be justified from a cost of view
- Expedient and efficient change procedures must be followed to avoid any delay in evaluation
- Owner should expand more effort in the early development of the design to minimize changes during detail design and construction

CHAPTER 3: CAUSES, EFFECTS AND CONTROLS

The areas of causes, effects and controls of change orders are to be examined in order to find out how these change related issues are viewed and treated by Saudi consultants and contractors.

3.1 Causes

The possible causes of change orders in construction of large buildings are:

1. Change of planes by owner.
2. Owner financial difficulties.
3. Owner change of schedule.
4. Ill –defined project objective
5. Substitution of material or procedures.
6. Conflict between contract and document.
7. Change in design.
8. The scope of work for the contractor is ill-defined.
9. Error and omissions in design.
10. Lack of coordination.
11. Value engineering.
12. Technology change
13. Differing site conditions.
14. Contractor desire to improve his financial conditions.
15. Contractor financial difficulties.
16. Unavailability of skills.
17. Unavailability of equipment.
18. Defective workmanship.
19. Safety consideration.
20. Weather condition.
21. New government regulations.

3.2 Effects

Effects of change orders that are usually encountered are:

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

3.3 Controls

This Section review the common control procedures used to minimize the effects of change order. This includes measures taken prior to start of construction and before generation of change orders and measure taken to minimize impact of change orders after they have been generated:

1. Clarify change order procedures
2. Quick Approval
3. Ability to Negotiate changes
4. Approval in writing
5. Change order Scope
6. Pricing of indirect effects
7. Justification of changes
8. Review of contract document
9. Freezing Design
10. Team effort
11. Use of WBS

CHAPTER 4: SURVEY QUESTIONNAIRE

4.1 Questionnaire Design

For the purpose of designing the questionnaire, great efforts and brainstorming have been applied. Also, key industry members have been met to identify the right questions to be included in the questionnaire and make it clear to respondents. Arabic and English versions have been developed as some of the respondents may not be fluent in English while a special care was taken to come up with an easy-to-understand questionnaire.

4.1.1 Contents of the Questionnaire

The questionnaire included six sections. The first section includes instruction to respondents defining the key terms in the study and providing respondents with instructions on completing the questionnaire.

The second section contains general information about the respondents such as address, company size and type, etc.

The third section addresses the general industry characteristics such as size, experience, amount of change, etc.

The fourth section discusses causes leading to change orders. A list of causes of changes are read from the literature is presented and the respondent is asked to state the frequency of occurrence of these causes in his projects. The causes were further grouped as owner originated, designer/consultant originated, contractor originated or others for ease of analysis. Respondents were given a chance to add other causes and rate them.

The fifth section addresses the possible effects of change orders. This list was developed from the literature review. Responses in this section are given on a S-point scale starting with VERY OFTEN and ending with NEVER.

The last section in the questionnaire addresses the normally adopted controls of changes in the construction industry and the administrative procedures set to minimize their impact.

4.1.2 The Statistical Sample

The selection of respondents was limited by four restrictions: large projects (\geq SR 20MM), large contractors (\geq Grade 2), building projects and projects located in the Eastern province of Saudi Arabia.

With these restrictions in mind, the forty two (42) contractors and forty one (41) consultants from the Chamber of commerce's list were targeted in this research. To determine the sample size from each population, the below equations were used:

$$n_0 = (p*q)/V_2 \quad \text{----- (1)}$$

$$n = n_0/[1+(n_0/N)] \quad \text{----- (2)}$$

Where;

n_0 : First estimate of sample size

p: The proportion of the characteristic being measured in the target population

q : Complement of 'p' or 1-p

V : The maximum standard error allowed

N : The population size
n : The sample size

To maximize n, p is set at 0.5. The target populations N are 42 and 41 for contractors and consultants respectively. To account for more error in qualitative answers of this questionnaire, maximum standard error V, is set at 10% or 0.1. Substituting in Equations 1 and 2 above, minimum required sample is calculated to be 15.67 and 15.53 for contractors and consultants respectively. This means that minimum sample size for each population is 16.

4.1.3 Gathering of Data

Since mailed and faxed questionnaires have resulted in poor responses, follow-up telephone calls and subsequent visits to consultants & contractors offices and some clarifications have been made to respondents about questions in the forms. Over a period of three months, the researcher collected 37 responses from which 20 were contractors and 17 were consultants. This means a rate of response of 47% for contractors and 41% for consultants.

To maintain the original 1:1 ratio between the original populations, the researcher decided to use only 17 contractors' responses and all 17 consultants' responses.

4.1.4 Scoring

No scoring will be used for questions in sections II and III of the questionnaire, since these sections contain general information and characteristics of the market.

Sections IV, V, and VI on causes, effects, and controls respectively will be scored as follows to come up with an Index to indicate its importance, or utilization as in the case of controls of each:

Very often	= 100%
Often	= 75%
Sometimes	= 50%
Seldom	= 25%
Never	= 0 %

Importance Index, Prevalence Index and Utilization Index of each causes, effects and controls are calculated as follows:

$$IIC_1 = 100x_1 + 75x_2 + 50x_3 + 25x_4 + 0x_5 / (x_1 + x_2 + x_3 + x_4 + x_5)$$

Where:

- II : Importance Index (C1 denotes cause 1 in this case)
- X₁ : Number of respondents answering (VERY OFTEN)
- X₂ : Number of respondents answering (OFTEN)
- X₃ : Number of respondents answering (SOMETIMES)
- X₄ : Number of respondents answering (SELDOM)
- X₅ : Number of respondents answering (NEVER)

CHAPTER 5: RESULTS AND FINDINGS

Causes, effect and controls categorization criteria are different for each of them as follows:

- Data analysis about causes are categorized by Importance Index (II)
- Data analysis about effects are categorized by Prevalence Index (PI)
- Data analysis about controls are categorized by Utilization Index

Hypothesis that “Contractors and consultants don’t agree on the causes of change orders” is tested in this study.

5.1 General Info & Industry Characteristics

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. It also has information on the level of owner involvement, extent of cost and schedule overruns due to changes, and type of contract formats employed. Survey results on general characteristics in this section are presented in graphical representation.

As expected, contractors are larger in size (number of employees) than consultants. The results shows that most consultants companies (70%) have less than 200 employees whereas only 35% of the contractors have less than 200 employees.

The level of experience among participating contractors and consultants are classified as follows:

- Very Long (more than 15 years)
- Long (10-15 years)
- Short (5-10 years)
- Very Short (less than 5 years)

Over 50% of the contractors and about 60% of the consultants reported over 15 years of experience. None of the contractors and consultants participating in the survey has experience of less than 5 years.

Survey questionnaire included five choices of the type of construction contract format:

- Lump Sum Turn Key (LSTK.)
- Cost Plus (C+)
- Lump Sum for Labor (LS-LBR)
- Design and build (D&B)
- Other Formats

65% of respondents said that construction contracts of their projects are lump sum turnkey type (LSTK). 18% indicated that construction contracts of their projects are lump sum for labor work only (LS-LBR). None of the respondents reported design and build (D&B) type contract.

From the aspect of the distribution of change orders over the different construction crafts, it is found that, 21 out of 34 contractors and consultants (over 60%) indicated that civil/structural is the most change order generating craft in large-building construction. 23% of respondents said electrical is the most change order generating craft.

Concerning the relation between the principal parties in the construction process, the owner, the contractor, and the consultant, it is shown that 61.8% have either excellent or very good relation with the other parties. Only 3 cases indicated a fair or poor relation among principal parties.

The level of owner involvement is expressed in terms the stages he get involved in the process of design and construction of the project. 41.2% of the respondents said that the owner gets involved in both design and construction stages while 21.6% said that the owner gets involved in the design stage only. 35.3% indicated that the owner gets involved in the construction stage only.

With regards to the percent increase in project cost due change orders, over 50% of both contractors and consultants said the percent increase due to change orders is 6 to 10% of the total project cost. 26% reported a cost overrun between 11-15%

As for 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 the original schedule. Less than one percent said the increase is more than 20%.

5.2 Causes of Change Orders

The data provided by contractors is examined and that will be the basis for case selection. For these cases, minimum and maximum values and the standard deviation is reported to see the dispersion of data. Importance Index (II) is also calculated.

The same analysis will be carried out on data from consultants. Finally, overall data will be analyzed calculating importance indexes for the overall data and comparing data from contractors to that of consultants.

Table-1 below lists the results f the survey for both contractors and consultants.

The ranking of the different causes or sources of change orders based on importance indexes is presented in Table-2 below for contractors, consultants as well as the overall ranking.

Table-1

Source or Cause of Change Order	Frequency	Severity	Standard Deviation	Importance Index (SI)
1. Change of plans by owner	0	100	26.07	73.53
2. Owner's financial problems	0	100	22.50	47.79
3. Owner's change of schedule	0	100	26.33	43.38
4. The objective of the project is not well defined	0	75	23.08	30.88
5. Substitution of materials or procedures	0	75	20.70	56.62
6. Conflict between contract documents	0	100	23.88	44.11
7. Change in design by consultant	0	75	17.16	44.85
8. The scope of work for the contractor is not well defined	0	75	23.93	35.29
9. Errors and omissions in design	0	100	23.65	52.94
10. The lack of coordination between contractor and consultant	0	100	25.60	43.38
11. Value engineering	0	75	20.90	32.35
12. Technology changes	0	50	16.64	31.62
13. Differing site conditions	0	100	23.74	41.18
14. Contractor's desire to improve his financial situation	0	100	30.16	34.56
15. The contractor's financial difficulties	0	75	26.03	33.82
16. The required labor skills are not available	0	75	23.42	25.73
17. The required equipment and tools are not available	0	50	19.59	21.32
18. Workmanship or material not meeting the specifications	0	75	22.83	27.94
19. Safety considerations	0	100	24.25	32.35
20. Weather conditions	0	75	21.75	24.26
21. New government regulations	0	50	19.25	19.85

Table-2

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

The overall ranking of the top five causes of changes 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's financial problems.
5. Change in design by consultant.

5.3 Effects of Change Orders

In this section, the response of contractors and consultants about the effects of change orders on large construction projects in Saudi Arabia will be examined.

The 17 responses received by contractors on the effects of change orders were widely dispersed reflecting the wide variation of opinions. From the contractor's point of view, the top five effects on change orders listed in ascending order are:

1. Delay in completion schedule
2. Increase in project cost
3. Increase in contractor's overhead
4. Decrease of productivity of workers
5. Additional revenue for contractors

On the other hand, the consultants ranked the same effects differently as follows:

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

The overall results of the survey of responses on effects of change orders in large construction building construction considering both contractors and consultants is shown in Table-3 below:

Table-3

Effect of Change Order	Contractors	Consultants	Contractors	Consultants
	Rank	Frequency	Weighted Rank	Prevalence (Rank/Freq)
1. Decrease in productivity	0	100	31.85	55.15
2. Delay in completion schedule	25	100	22.19	75
3. Dispute between owner and contractor	0	100	29.07	56.62
4. Decrease in quality of work	0	75	24.63	34.56
5. Increase in project cost	25	100	20.75	77.21
6. Additional revenue for contractor	25	100	23.93	66.67
7. Delay of material and tools	0	75	16.21	51.47
8. Work on hold in other areas	0	100	20.21	55.15
9. Increase in contractor's overheads	0	100	20.90	57.35
10. Delays in payment to contractor	0	100	27.20	42.65
11. Demolition and re-work	25	100	22.29	60.29

From the above table, the five most prevalent effects can be listed as follows:

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

The ranking of effect of change orders on the construction process based on the prevalence index of these effects is presented in Table-4 below:

Table-4

Effect of Change Order	Ranking By Consultants	Ranking By Contractors	Overall Ranking
1. Decrease in productivity	8	4	7
2. Delay in completion schedule	2	1	2
3. Dispute between owner and contractor	4	9	6
4. Decrease in quality of work	9	10	10
5. Increase in project cost	1	2	1
6. Additional revenue for contractor	3	5	3
7. Delay of material and tools	8	7	8
8. Work on hold in other areas	6	7	7
9. Increase in contractor's overhead	7	3	5
10. Delays in payment to contractor	9	8	9
11. Demolition and re-work	5	6	4

5.4 Controls of Change Orders

Similarly, the responses from contractors and consultants about the controls of change orders in large building construction projects in Saudi Arabia were examined and the results were reported.

In order to eliminate or minimize the impact of change orders, contractors have utilized the following controls:

1. Clarity of scope of work of the change order.
2. Negotiation of change orders by knowledgeable people.
3. Appropriate approval in writing.
4. Early setting of change order procedures.
5. Review of design changes for feasibility before approval.

On the other hand, the controls used by the consultants can be ranked as follows:

1. Clarity of the scope of work of the change order.
2. Review of design changes for feasibility before approval.
3. Appropriate approval in writing.
4. Team effort among construction parties.
5. Negotiation by knowledgeable people.

The overall ranking of utilized controls of change orders is shown in Table-5 below:

Table-5

Controls of Change Order	Ranking By Consultants	Ranking By Contractors	Overall Ranking
1. Early setting of change order handling procedures	5	4	4
2. Timely approval of change order	8	7	5
3. Negotiation by knowledgeable people	4	2	2
4. Appropriate approval in writing	3	3	2
5. Clarity of scope of change	1	1	1
6. Giving consideration to indirect effects in change order pricing	6	10	6
7. Checking and review of design changes for feasibility	2	5	3
8. Review of gray areas in contract documents	7	9	6
9. Freeze of design	9	11	7
10. Team effort between parties	3	6	4
11. Workbreak down structure	8	8	6

The five top controls utilized by contractors and consultants are:

1. Clarity of the scope of work of the change order.
2. Appropriate approval in writing.
3. Negotiation by knowledgeable people.
4. Review of design changes for feasibility before approval.
5. Team effort among construction parties.

Table-6 summarizes the most important causes, effects, and controls for both contractors and consultants.

Table-6

Causes	Contractors Effects	Controls
1. Change of plans by owner	1. Delay in completion schedule	1. Clarity of CO scope of work
2. Errors and omissions in design	2. Increase in project cost	2. Knowledgeable people for CO negotiation
3. Changes by consultant	3. Increase in contractor overheads	3. Approval in writing
4. Substitution of materials and procedures	4. Decrease in labor productivity	4. Early setting of CO procedures
5. Conflict within contract document	5. Additional revenue for contractors	5. Review of CO for feasibility
Consultants		
1. Change of plans by owner	1. Increase in project cost	1. Clarity of CO scope of work
2. Substitution of materials and procedures	2. Increase in project schedule	2. Review of CO for feasibility
3. Owner financial problems	3. Additional revenue for contractors	3. Approval in writing
4. Owner's change of schedule	4. Dispute between owner and contractor	4. Team effort
5. Lack of coordination	5. Demolition and rework	5. Knowledgeable people for CO negotiation

5.5 Test of Agreement

In this section, the degree of agreement or disagreement between the consultants and contractors on the causes, effects, and controls of change orders is tested. To do this the t-test for independent samples is used. The analysis here was done on the mean values for causes, effects, and controls.

The null & alternative hypotheses (H_0 & H_A) are formulated as shown below and the degree of agreement or disagreement between consultants and contractors on the causes, effects and controls of change orders is tested.

- H_0 : Contractors and consultants agree on the causes of change orders.**
 H_A : Contractors and consultants disagree on the causes of change orders.

Similar formulation is done on the effects and controls of change orders to perform the test on the hypotheses.

The test results of the hypotheses were as follows:

- Contractors & Consultants **do** agree on the **causes** of change orders.
- Contractors & Consultants **do** agree on the **effects** of change orders.
- Contractors & Consultants **do** agree on the **controls** of change orders.

5.6 Comments from Respondents

Some comments were made by consultants and contractors on the questionnaire forms and are documented for reference and future studies. The most important ones are listed below:

- By Consultants
 - a. Accuracy of documents, drawings, specs and bill of quantities is required.
 - b. Coordination is very helpful.
 - c. Improvement of project management in governmental project is necessary.
 - d. Use of project management consultants (PMC) is recommended.
 - e. All finishing materials and equipment should be selected & approved prior to construction.
- By Contractors
 - a. Consultants should explain the design to the owner clearly to have full understanding.
 - b. Site conditions and design packages should be studied carefully by the owner.
 - c. Cost of change order should be negotiated before commencement of any work.
 - d. Owners should consider the negative effect of change orders and try to avoid it by doing a good design before calling for bidding.

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

The significance of the study of change orders, the objective, the scope and limitations to the study followed by some literature review about legal and cost aspects of change orders are discussed in the first two chapters. The third chapter defines the parameters to be measured in the field survey. The process of developing the questionnaire and the method used to come up with the different indexes and ranks are discussed in the fourth chapter. Chapter five summarizes the results and findings from the contractors and consultants on the causes, effects and controls of change orders and ranks them accordingly.

6.2 Conclusion

The causes of change orders, 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 changes, their effects on projects, and control procedures adopted in large building projects in Saudi Arabia.

Based on the field survey conducted and the results found, the following as can be concluded and outlined:

- Changing the plans by the owners is the main source of change orders. That is due to lack of involvement in the design development and inability to visualize it while not appreciating the negative effect of it.
- Because of new materials are becoming available in the market or change in mind, substituting materials and/or procedures is the second source of change orders.
- Consultants are the second major contributor to changes by generating conflicting design documents or through change in design afterwards.
- Increase in project cost and duration are the main two effects being noted for change orders.
- Clarity of scope of change orders ranked the first among controls adopted.

6.3 Recommendations

As per the findings of this research and the conclusion given above, the following can be recommended:

- Make use of 3D models to help owners see their project before construction starts. Animation would be greater!
- Owners to make a good financial planning during planning stage.
- Owners are advised to have PMC to supervise both design and construction to ensure that owner's expectations are met by the design.
- Consultants to specify the materials in a detailed matter or use performance specifications.
- Owners to use the control of "freezing the design" more often to avoid the problem of creeping scope.

6.4 Recommendations for Further Studies

The following are areas of related interest that can be explored in light of information provided in this study:

- a. A field survey is required to more focus on the area of the owners to investigate why the owners make change orders, what they can do during the design stage and whether they prefer to see a model of their project before construction.
- b. Since this study addresses the subject for large building project, it would be interesting to study the subject of change orders in the industrial construction projects and compare the results.

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