A Study On Impacts Of Change Order In Construction Projects

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Abstract - In construction projects, changes are very common and likely to occur at any stage of the project. Construction project is a complex process, which requires close cooperation and coordination among the stakeholders. The process also consists of different stages, which ultimately make it more complicated and difficult to manage. A good design will enhance value generation, reduce dispute and improve the workflow. As the designing work begin undertaken there are tendencies for changes in design to happen. These changes can take place right from the drawing stage up till the construction phase. The later the changes are made, the more of it will affect the project. In the actual design environment, changes inevitably and continuously affect the properties of many building components at various stages in a construction project. Such changes may occur due to the needs to satisfy the new or modified requirements specified by the owner, to reduce project cost, or to rectify existing design mistake. To make things worse most of the changes were made during construction stage. These will generate change orders, contractual disputes, cost overrun, time delay, compromising on quality and frustration. In addition to that parties which are involved in the process of making the changes into reality will need to submit fresh claims on the extra work done. This paper reviewed the various causes, effects, and control procedure for changes based on the basic ideas, the legal aspects, the cost and pricing aspects, and the management and administration of change orders. The outcome of this review may help the engineers and contractors to improve productivity, to control the changes in the field and to enhance the effective change management process and initiate further research in this field.

Keywords: Construction industry, Change, Change order, Causes, Effects, Change management

1. INTRODUCTION

Construction industry is one of the rapid growing sector in India. A number of construction projects are currently undergoing in various fields of civil engineering. Large and complex projects have been built which attracting contractors and construction companies from all over the country. Most of the contractors and their companies lack sufficient understanding of the local social, cultural and physical environment. During the development phases of any of the construction project, many decisions have to be made based on the incomplete information, personal experiences, assumptions, or generally uncertain conditions which can lead to adjustment at a later stage of the project. Incomplete information on the project variables at the early stages of projects leads to inadequate knowledge of future conditions, This situation coupled with inexperienced owners has led to inadequate design resulting in changes to plans, specifications, and contract terms. Consequently, it may result in imprecise estimates arising from ambiguity in project parameters. It may be inferred that the clients’ dissatisfaction is likely caused by change orders running through the construction projects. The effort of managing change orders has imposed a huge burden on project management, and it is a nightmare that industry people wished they never have to face. Changes in construction also cause serious ethical problems and disputes. Change management is a pure application-oriented issue and requires engineering innovation to solve the problem. Based on our investigation of the construction change order process, and a pressing need from industry versus the scarcity of literature and software tools in the domain, poses a promising opportunity for research and development in construction.

The following section summarize the various impacts of construction change order process and provides some insightful thoughts on this topic.

Definition

“In construction projects, a change refers to an alteration or a modification to pre-existing conditions, assumptions and basic information, or requirements (project or client)” (EPSRC, 2004). It includes work, time, cost and method of performance.

Change of planned design, construction procedure and contract terms during execution of work leads to the 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.

2. OBJECTIVE OF THE STUDY

The study is aimed to provide an understanding of what causes change order and their relative effects to the engineering consulting firms. In addition it will also look into the nature of claims made by the construction professionals and suggest some improvement on the current practice.

The main objectives of the study are

- Identify the main causes of construction change orders.
- Identify the severity of those causes.
- Test the hypothesis that construction professionals disagree on the severity of causes.
3. METHODOLOGY

This study started off with the problem identification which done through unstructured interview and brief literature reading. Upon obtaining the identified problem thorough literature review were conducted to provide in depth understanding on the issues of change order, focusing on the causes and effects. The study will be limited to large building construction projects in the southern region of India. It is focusing only on the causes and effects of changes and change order. The study was conducted using questionnaire survey that was sent out to the engineering contractors. The objective of the survey is to obtain more extensive coverage on the issue of change order and claims made by the by engineering contractors on extra works caused by change order. Upon obtaining the data desired, checking and sorting of data were done and followed by data analysis which was the main component of the study. Finally from the data analysis acquired conclusion and recommendation were made. The respondents involved were only the engineering contractors. The suggestion made is only focusing on method to reduce changes.

3.1 Contents of the Questionnaire

The questionnaire is divided into four sections. The first section contains general information about the respondents such as contact address, company size, type and the general industry characteristics such as size, experience, amount of change etc. Questions in the last two sections are posed in a multiple choice question format. The second section addresses causes leading to change orders. A list of major causes of changes as read from the literature is presented and the respondent is asked to state the frequency of occurrence of these causes in his projects. Most frequent causes correspond to ‘very often’ whereas the least frequent correspond to ‘never’ which denies existence of the condition as a cause. 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. A review of these causes is presented in section 4.1 above. The third section addresses the possible effects of change orders. This list was developed from the literature review. A review of these effects is presented in section 4.2. Responses in this section are given on a 5-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. A review of these controls is presented in section 4.3. Likewise, responses in this section are given on a 5-point scale.

3.1.1 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.

3.1.2 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.

3.1.3 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 

3.2 ANALYSIS

Causes, Effects, and Controls are 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:

\[ IIc_1 = 100 x_1 + 75x_2 + 50x_3 + 25x_4 + 0x_5 / (x_1 + x_2 + x_3 + x_4 + x_5) \]

Where:

- **II** : Importance Index (C1 denotes cause 1 in this case)
- **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)

### 4. RESULTS AND DISCUSSION

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

#### 4.1 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.

<table>
<thead>
<tr>
<th>Source or Cause of Change Order</th>
<th>Mean</th>
<th>Importance Index (II)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Change of plans by owner</td>
<td>26.86</td>
<td>70.59</td>
</tr>
<tr>
<td>2. Owner’s financial problems</td>
<td>26.18</td>
<td>42.65</td>
</tr>
<tr>
<td>3. Owner’s change of schedule</td>
<td>28.11</td>
<td>36.75</td>
</tr>
<tr>
<td>4. The objective of the project is not well defined</td>
<td>22.58</td>
<td>30.88</td>
</tr>
<tr>
<td>5. Substitution of materials or procedures</td>
<td>24.81</td>
<td>52.94</td>
</tr>
<tr>
<td>6. Conflict between contract documents</td>
<td>24.63</td>
<td>42.65</td>
</tr>
<tr>
<td>7. Change in design by consultant</td>
<td>12.5</td>
<td>50</td>
</tr>
<tr>
<td>8. The scope of work for the contractor is not well defined</td>
<td>25.18</td>
<td>36.74</td>
</tr>
<tr>
<td>9. Errors and omissions in design</td>
<td>26.60</td>
<td>60.29</td>
</tr>
<tr>
<td>10. The lack of coordination between contractor and consultant</td>
<td>26.69</td>
<td>36.75</td>
</tr>
<tr>
<td>11. Value engineering</td>
<td>23.29</td>
<td>33.82</td>
</tr>
<tr>
<td>12. Technology changes</td>
<td>16.60</td>
<td>30.88</td>
</tr>
<tr>
<td>13. Differing site conditions</td>
<td>26.43</td>
<td>41.17</td>
</tr>
<tr>
<td>14. Contractor’s desire to improve his financial situation</td>
<td>26.52</td>
<td>25</td>
</tr>
<tr>
<td>15. The contractor’s financial difficulties</td>
<td>26.52</td>
<td>25</td>
</tr>
<tr>
<td>16. The required labor skills are not available</td>
<td>20.67</td>
<td>23.53</td>
</tr>
<tr>
<td>17. The required equipment and tools are not available</td>
<td>20.22</td>
<td>20.59</td>
</tr>
<tr>
<td>18. Workmanship or material not meeting the specifications</td>
<td>24.81</td>
<td>27.94</td>
</tr>
<tr>
<td>19. Safety considerations</td>
<td>24.81</td>
<td>27.94</td>
</tr>
<tr>
<td>20. Weather conditions</td>
<td>24.81</td>
<td>27.94</td>
</tr>
</tbody>
</table>

![Fig 4.1.1: Importance Indexes of Causes](image-url)
The overall ranking of the top five causes of changes among all contractors 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.

4.2 Effects Of Change Order

Here, minimum and maximum values and the standard deviation is reported to see the dispersion of data. Prevalent Index (II) is also calculated.

Table 4.2.1: Prevalent Indexes of Effects

<table>
<thead>
<tr>
<th>Effect of Change Order</th>
<th>Mean</th>
<th>Prevalence Index ( PI )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Decrease in productivity</td>
<td>33.00</td>
<td>58.82</td>
</tr>
<tr>
<td>2. Delay in completion schedule</td>
<td>23.19</td>
<td>72.06</td>
</tr>
<tr>
<td>3. Dispute between owner and contractor</td>
<td>26.60</td>
<td>39.71</td>
</tr>
<tr>
<td>4. Decrease in quality of work</td>
<td>20.67</td>
<td>26.47</td>
</tr>
<tr>
<td>5. Increase in project cost</td>
<td>20.78</td>
<td>69.12</td>
</tr>
<tr>
<td>6. Additional revenue for contractor</td>
<td>21.83</td>
<td>57.81</td>
</tr>
<tr>
<td>7. Delay of material and tools</td>
<td>10.72</td>
<td>51.47</td>
</tr>
<tr>
<td>8. Work on hold in other areas</td>
<td>24.16</td>
<td>51.47</td>
</tr>
<tr>
<td>9. Increase in contractor’s overhead</td>
<td>23.48</td>
<td>60.29</td>
</tr>
<tr>
<td>10. Demolition and re-work</td>
<td>24.63</td>
<td>57.35</td>
</tr>
<tr>
<td>11. Delays in payment to contractor</td>
<td>27.62</td>
<td>42.65</td>
</tr>
</tbody>
</table>

Fig 4.2.1: Prevalent Indexes of Effects

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 contactors

4.3 Controls of Change Orders

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

Table 4.3.1: Utilization Indexes of Control

<table>
<thead>
<tr>
<th>Controls of Change Order</th>
<th>Mean</th>
<th>Utilization Index ( UI )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Early setting of change order handling procedures</td>
<td>35.29</td>
<td>66.18</td>
</tr>
<tr>
<td>2. Timely approval of change order</td>
<td>26.43</td>
<td>58.82</td>
</tr>
<tr>
<td>3. Negotiation by knowledgeable people</td>
<td>16.47</td>
<td>76.47</td>
</tr>
<tr>
<td>4. Appropriate approval in writing</td>
<td>25.72</td>
<td>73.53</td>
</tr>
<tr>
<td>5. Clarity of scope of change</td>
<td>17.41</td>
<td>77.94</td>
</tr>
<tr>
<td>6. Giving consideration to indirect effects in change order pricing</td>
<td>32.51</td>
<td>44.12</td>
</tr>
<tr>
<td>7. Checking and review of design changes for feasibility</td>
<td>33.14</td>
<td>64.71</td>
</tr>
<tr>
<td>8. Review of gray areas in contract documents</td>
<td>35.22</td>
<td>47.06</td>
</tr>
<tr>
<td>9. Freeze of design</td>
<td>25.09</td>
<td>35.29</td>
</tr>
<tr>
<td>10. Team effort between parties</td>
<td>33.21</td>
<td>61.76</td>
</tr>
<tr>
<td>11. Work-break down structure</td>
<td>33.62</td>
<td>48.53</td>
</tr>
</tbody>
</table>

Fig 4.3.1: Utilization Indexes of Control

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

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.
5. 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 India. 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. RECOMMENDATIONS

As per the findings of this study 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.

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