Impact of Change Orders on Building Construction Projects in Maharashtra

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Abstract- *A major problem in construction projects is change orders. It is common in all types of construction projects and plays an important role in determining the final cost and duration of projects. The change orders usually issued to cover variations in scope of work, material quantities, design errors and unit rate changes. The study examines variations in construction projects by investigating causes of variations, studying their effects on the projects and suggesting remedies to related problems. To achieve the study objectives, review of relevant literature was done with questionnaire survey to collect information on causes and effects of variations in construction projects in Maharashtra. In order to obtain view of consultants and contractors in the industry, a survey was conducted for 30 construction sites using questionnaire which includes 10 consultants and 20 contractors. The study was able to isolate 14 critical causes of changes in orders. It was determined that "client's additional work, change of plans or scope by consultant and modifications to design" were the most important causes of change order. The most important effects of change order on the projects were found to be "schedule delays, disputes and cost overruns. The most important causes and effects of change order were evaluated using relative important index and mean score was calculated. It was recommended that technical experts like Quantity Surveyor and Cost controller along with Project Manager should be appointed so that the effects due to variation orders on the successful completion of project can be minimized.*

Keywords- Change Order, causes , Effects, Relative Importance Index

I. INTRODUCTION

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.

Changes in drawings and contract documents usually lead to change in contract price or contract schedule. Changes also increase the possibility of contractual disputes. Construction projects are complex because they involve many human and non-human factors and variables usually have a long duration, various uncertainties and complex relationships among the participants.

Maharashtra Region has in the last ten years experienced a huge volume of work in the field of construction. Maharashtra has a personality of its own, due to mythological, historical, social and cultural importance.This has resulted in very rapid growth and transformations during that period. The high living standards of the people have generated many manufacturing and building employment opportunities.

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, and technological developments may alter the design and the choice of the engineer. The engineer's review of the design may bring about changes to improve or optimize the design and hence the operation of the project. Further, errors and omissions in engineering or construction may force a change. All these factors and many others necessitate changes that are costly and generally un-welcomed by all parties. A contract change clause is added to define the way that owner, consultant, and contractor will handle changes. Given the fact that an adversarial atmosphere usually exists between the parties in the 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.

- **Problem Statement**

Variation order is one of the major issues in our construction industry. Project delay and cost overrun are the most common impact that has occurred due to variation order. The study is to be conducted by taking questionnaire interview of construction firms and assigning ranking to factors causing variation orders and effects due to variation orders according to their importance and finding out which factor is major and which one is minor effect on construction projects.

- **Objectives of Study**

1. To study of change order in construction projects by reviewing the literature and through the additions by the industry practitioners i.e. contractors, consultants and owners.
2. Identify the main causes of construction change orders through Relative Important Index according to the perspectives of contractors, consultants and owners.
3. Determining the impacts of change orders on cost and an analysis of data collection which contains RII of causes, effects and controls of variation orders.
4. Comparison of factors causing variation orders and effects according to Consultant's and Contractor's view and according to Private and Public projects.
5. Providing practical suggestions and recommendations pointing toward upgrading the management process in construction and improve the performance of contracting companies and owners in this field.

- **Scope of Study**

The scope of study for this topic will be a study on the causes of variation orders on construction project. Study on the causes of the variation orders will be related to the effects that occur after the variation orders are taken. The area of work of the study will focused on four case studies of construction projects that involved in variation orders works. The data collection will be gain from journal, article, internet, and questionnaire data from the related professional's parties who are relevant to the topics. After the overall analysis, there will be a suitable solution recommended and suggested to minimize the problems that occur from variation orders.

II. LITERATURE REVIEW

There have been numerous articles written on changes, change orders and change management in construction. Most of the articles written discuss the legal aspects of changes such as claims and disputes. Many other articles were devoted to the discussion of the effects of changes on labor productivity. Most of the research on changes as a separate construction issue is done by or under the guidance of the Construction Industry Institute (CII) an American national organization. Although this review is by no means a comprehensive one, it covers the most important articles and subjects and can open the door for further research on the subject of changes.

Panagiotis Ch. Anastasopoulos, Samuel Labi, Abhishek Bhargava, Claire Bordat and Fred L. Mannering (2010) (1) A common problem at state transportation agencies is the inability to complete projects within the original scope of work. Change orders, which are contractual documents issued to accommodate the additional work in a contract, are generally due to root causes such as design errors, unexpected site conditions, and weather conditions, and intermediate causes such as bidding characteristics. At the preaward phase of project management, an improved understanding of the factors that are associated with change orders will be of value and also can serve as a basis for taking steps to reduce concomitant contractual aberrations such as time delay and cost overruns. The completion of highway construction/maintenance projects within the original scope of work is an increasingly elusive goal for many transportation agencies. In a recent nationwide survey, 100% of respondents expressed concern about the issue of contractual

Aberrations particularly change orders, cost overruns, and time. A change order is a contractual document that is issued to accommodate any additional work in a contract that was not included in the original contract. The culture of practice at the Indiana highway agency is such that a recorded change order embodies all the components of the additional work not the individual components. It is found that the contract award amount and contract duration are significant factors associated with change-order frequency. Although there is a linear relationship between duration and change orders, the contract award amount is associated with the number of change orders in a manner that is nonlinear: for small contract amounts, incremental increases in contract amount yields sharp increases in change order frequency; but for a large contract, incremental increases in contract amount yields small changes in change-order frequency.

CII Publications 6-10 (1990) (2) 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 materials have been procured. Also successive changes cost more than a single change. Changes after construction or completion of design must provide high cost saving to be justified. Some owners request that a change must provide savings 10 times the direct cost required to implement them. "However if the idea that the cost of change can vary exponentially with time of introduction is accepted, that ratio should probably be 25:1 or higher in the later stage of detail design". It is clear that the relation between changes and time is an exponential function. The impacts of a change are classified in the literature as follows:

1. Direct cost impact
2. Direct schedule impact
3. Indirect or Consequential impact
4. Magnitude of impact
5. Costing of changes
6. Management aspects

III. METHODOLOGY

Variation order is one of the major issues in our construction industry. Project delay and cost overrun are the most common impact that has occurred due to variation order. The study is to be conducted by taking questionnaire interview of construction firms and assigning ranking to factors causing variation orders and effects due to variation orders according to their importance and finding out which factor is major and which one is minor effect on construction projects. The study was able to isolate 24 critical causes of changes in orders. A comprehensive list of causes and consequences of variation orders was compiled from a review of previous works which comprised of documented observations, opinion and views of various specialists and experts of more than 20 years' experience in the field. (Table 1) shows the various causes of variation orders in construction projects which were determined from above mentioned literature review. These causes were analyzed by mean score and relative important index from the view of all the participants of project.

The questionnaire as shown below divided into six sections. The first section includes instructions 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 contact address, company size, type etc. The third section addresses 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 fourth 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. The fifth section addresses the possible effects of change orders. This list was developed from the literature review. A review of these effects is presented. 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.

The outcome of the exercise as shown by responses monitored via a 5-point Likert scale viz-a-viz: Strongly disagree = 1; Disagree = 2; Neutral = 3; Agree = 4; and strongly agree = 5 indicated that construction works will always be subjected to the phenomenon of variation orders.

THE Most important mean rank scores were computed for each cause from the perspective of the employer, consultants and contractors score through the determined by the evaluation of mean score and relative important index.(table 2)

The overall ranking of most important factors causes, effects and procedures of variation orders control on construction projects was determined by the evaluation of mean score and relative important index.

The mean score for each factor was calculated by the following formula:

$$MS = \frac{\sum F \times S}{N}$$

Where, S=score given to each factor by the respondents, ranging from 1 to 5 where 1 is Strongly disagree and 5 is Strongly agree; F=frequency of responses to each rating 1to5 for each factor; and N is total number of respondents for that factor.

The relative important index was calculated using the following equation. This equation was used to calculate importance of variation factors according to survey responses.

$$RII = \frac{Totol\ Point\ Score}{5 \times N}$$

IV. IMPACT OF CHANGES ON COST ANALYSIS

Information for the study was obtained from different sources such as documents from the completed residential projects, through personal interviews, and in-depth discussions with the professionals, consultants, and contractor involved in projects Data were collected in a concurrent form from case studies and interviews

Case studies approach used in this study encompassed 5 residential building projects. Carried out in the Maharashtra were also investigated to collect the information required for study and analysis. The purpose of case studies approach was to obtain data from the source documents of the completed projects. The source documents included the contract documents, variation orders documents, bill of quantities. The impact of each change order on cost was determined from projects' documents and interviews.

- **Measuring Techniques**

Change orders have an impact on cost, whose direct changes can be easily calculated. However, items such as home-office overhead, increased labor costs, equipment and material costs, financing costs, and overhead, are not easily Quantifiable (Abdul-Malak et al, 2002).

The change in cost was defined as the difference between the cost at the end of the project and the original budget as reflected in

$$\text{Change in cost (\%)} = \frac{final\ cost - origanal\ budget}{original\ budget} \times 100$$

The increases in cost resulting from any major additions or alterations in the design which may eventually increase the project cost. In every construction project, a contingency sum is usually allocated to cater for possible changes in the project, while keeping the overall project cost intact (Arain and Pheng, 2005).

$$\text{\% inc. due to change} = \frac{cumulative\ cost\ of\ the\ change\ order\ to\ date}{\text{origanal cost of project}} \times 100$$

V. RESULTS AND FINDINGS

Causes of variation orders

From the review of previous works carried out in the current study, 30 factors responsible for variation orders were identified and the data collected from the part of the questionnaire was also analyzed

Now, if we list the five most common causes of change orders from the consultant's point of view for private projects, we have the following list starting with the most important:

1. Change of plans by owner.
2. Substitution of materials or procedures.
3. Owner's financial problems.
4. Owner's change of schedule.
5. Lack of coordination between contractor and consultant.

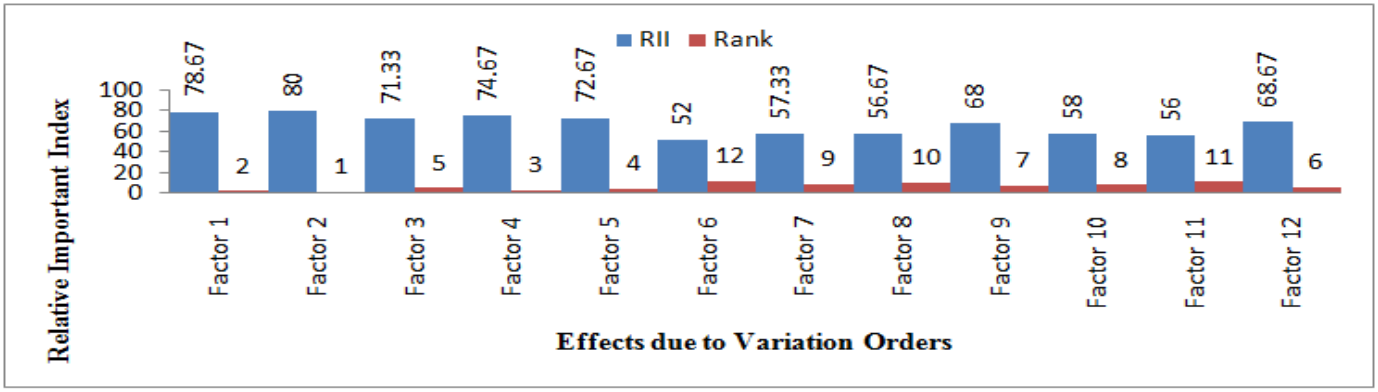
It might be noted that all these causes are originated either by the owner or by the designer/consultant. This is expected since each party is trying to blame the other for causing changes in construction.

- **Effects of variation orders**

There are numerous effects brought about by changes and change order in construction. In this section we examine some of these effects which are commonly encountered.

Table 1 :RII of effects due to variation orders for Private projects

Sr. No.	Effects of Variation Orders	RII	R
1	**Delay in completion schedule**	**78.67**	**2**
2	**Increase in project cost**	**80.00**	**1**
3	**Decrease in quality of work**	**71.33**	**5**
4	**Disputes between owner and contractor**	**74.67**	**3**
5	**Additional revenue for contractor**	**72.67**	**4**
6	Adversely affect the performance and moral of labour	52.00	12
7	Decrease in productivity	57.33	9
8	Delay of material and tools	56.67	10
9	Work on hold in other areas	68.00	7
10	Delays in payment to contractor	58.00	8
11	Increase in contractor's overhead	56.00	11
12	Demolition and re-work	68.67	6



Graph 1: Effects due to Variation Orders

From the survey point of view, the top five effects (prevalence) of change orders on their large building projects listed in descending order are:

1. Increase in project cost.
2. Delay in completion schedule.
3. Disputes between owner and contractor.
4. Additional revenue for contractor.
5. Decrease in quality of work.

- **Impact of changes on Building construction projects**

Tables.2 referred to projects handled by the consultant showing that the variation on the projects affected the projects by both cost and time overruns, From Table , the total initial contract sum was 255588000.00 Rupees and the final cost was 298713448.00 , this represent an approximate cost overrun of 11.35%. The result shows an increase in the duration of the projects from 88 months to 97 months, representing an average of 10.23% time overrun.

Table 2: Projects Managed by the In-house staff

Case number	Contractor Sum	Final cost	% Cost due to variation	Initial Duration (Months)	Final Duration (Months	% Time overrun due to variation
Case1	125000000	1650000000	32.00	24	28	16.66
Case 2	3500000	400000	12.5	8	9	12.50
Case 3	78500400	80800600	2.85	24	26	8.33
Case 4	35050000	39050000	11.41	18	20	11.11
Case 5	13,737,600	13,462,848	-2.00%	14	14	0.00
Total	**255588000**	**298713448**	**11.352**	**88**	**97**	**10.23**

VI. DISCUSSION AND CONCLUSION

This study also provides overall important effects of variation order on construction projects like delay in completion schedule, increase in project cost, disputes between owner and contractor and increase in contractor's overhead.

According to the analysis following are the effects due to variation orders from different project participant's view as per top Rank:

Consultant's view for Private Projects:

1. Increase in project cost.
2. Delay in completion schedule.
3. Disputes between owner and contractor.

Consultant's view for Public Projects:

1. Increase in project cost.
2. Delay in completion schedule.
3. Decrease in quality of work.

Contractor's view for Private Projects:

1. Delay in completion schedule.
2. Increase in project cost.
3. Increase in contractor's overhead.

Contractor's view for Public Projects:

1. Delay in completion schedule.
2. Increase in project cost.
3. Abandon work in incomplete position.

There are clear evidences from various literatures that variations contribute to cost and time overruns of a project. Although various research only focuses on the causes and impact of variation order on construction projects but without consideration for the effects of project handler in relation to the causes of variation order.

In Maharashtra, change orders played a significant role in construction because they had a great impact on cost, schedule.

1. The Total impact of change orders increased the cost on minimum by 2.85%, average by 11.35% and maximum by 32.00%.
2. The total impact of change orders decreased the cost by 2%,
3. The total impact of change orders increased the time on minimum by 8.33%, mean by 10.23%, and maximum 16.66%.

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