International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 05, May-2015

Study of Impacts due to Work Change on Performance of Construction Projects

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***Abstract*: The information given in the contracts and specifications at the time of bidding. They plan tasks and assign resources for each task on the basis of this information. as projects progress, the scope of the work may change. These changes may include alterations to the sequence of work, to the design, or changed conditions. Work changes may affect originally planned schedule and methods. the most realistic approach to manage these changes are to identify the factors causing the change, studying its impacts and to evolve procedures to avoid or minimize changes from the results obtained from the study. The study identifies the sources of changes, classifies the changes, quantifies the impact of changes and interprets the impacts considering an ongoing project. The research analyses and quantifies beneficial and adverse impacts due to constructional changes. The causes and impacts of work change in two construction projects in pune region, Maharashtra were investigated. An analysis of the most likely causes and effects were performed. The project investigated how different parties (client, consultant and contractor) deal with these problems through the result obtained from a field survey conducted through a questionnaire's response. Remedies for negative impacts were recommended to alleviate its impact on the construction projects. Suggestions on how change can be avoided or minimized were also presented which helps in managing changes, which occur in a construction project, effectively.**

Index Terms— Work changes, client, consultant and contractor

I. INTRODUCTION

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. The most realistic approach to manage these changes are to identify the factors causing the change, studying its impacts and to evolve procedures to avoid or minimize changes from the results obtained from the study. The work

Changes may produce several adverse impacts like increase in project cost; affect orderly sequence, decreased productivity, schedule delays, disputes and claims etc. It can also be beneficial in the view of quality enhancement, to rectify any Unforeseen circumstances, omissions in designs or changed condition etc. The study identifies the sources of changes, classifies the changes, quantifies the impact of changes and interprets the impacts considering an on-going project. The research analyses and quantifies beneficial and adverse impacts due to constructional changes. It present remedies for negative impacts

II. OBJECTIVES OF STUDY

1 To provide a deeper insight to work changes and variations.
2. To identify the sources of work changes.
3. To analyses and quantify beneficial and adverse impacts due to constructional changes.
4 To present recommendations to minimize and manage changes in on-going construction projects

III. METHODOLOGY

Steps involved in monitoring and control of impact of changes are:
The study started with problem identification which is done through unstructured interview and brief literature reading. Upon obtaining the identified problem, thorough literature review were conducted to provide in depth understanding the issues of work changes in construction industry, focusing on the causes and effects to civil engineering construction industry.
The literature includes books, dissertations, magazines, International journals from Journal of Construction Engineering and Management, International Journal of Project Management, newspapers readings, e-references and seminar notes.

Apart from literature review two case studies were selected which is having problems that are defined in the scope of dissertation topic. The data for case study is collected by directly interviewing with the concerned site personnel and their suggestions are also incorporated. A questionnaire survey is also conducted by distributing a well prepared questionnaire to various experts in the construction field. The questionnaire is prepared by referring to various literatures published in standard journals. The objective of the case studies and survey is to obtain a more extensive coverage of the actual practical scenario in the construction industry on the issue of work change and change orders, its causes, its effects and its management. Upon obtaining the data desired, checking and sorting of data were done and followed by a data analysis which was the main component of the dissertation. Finally from the data analysis acquired conclusion and recommendations were made.

IV. CATEGORIES OF DELAY AND IMPACT OF CHANGE

Cause of delays in construction projects are mainly as:

1. Change of Plans by Owner
2. Owner Financial Difficulties
3. Owner Change of Schedule
4. Ill-defined Project Objectives
5. Substitution of Materials or Procedures
6. Conflict between Contract Documents
7. Change in Design
8. The Scope of Work for the Contractor is Ill-defined
9. Errors and Omissions in Design
10. Lack of Coordination
11. Technology Changes
12. Differing Site Conditions
13. Contractor Financial Difficulties
14. Unavailability of Skilled Labour
15. Unavailability of Equipment
16. New Government Regulations

Impacts of changes:

1. Delay in Completion Schedule:
2. Dispute between Owner and Contractor
3. Decrease in Quality
4. Increase in Project Cost
5. Additional Money for Contractor
6. Delay of Material and Tools
7. Increase in Overhead Expenses
8. Delay in Payment
9. Demolition and Re-work

V DATA COLLECTION

A data is collected with the help caste study for analyzing the reasons of delay in live construction projects.

Case Study 1: Widening of Sancheti Rail Over Bridge, Shivajinagar, Pune

Case Study 2: Renovation and Landscaping Work of Head Quarters Building, Maharashtra State Agricultural Marketing Board, Market Yard, Pune.

VI. ANALYSIS OF DATA

Analyzing Results of Questionnaire:-

The aim of the questionnaire is to obtain a satisfactory ranking for the causes of changes and its impacts. It also provides suggestions given by experts.
The questionnaire is mainly based on Likert's scale of 5 ordinal measures from 1 to 5 ranking according to level of contributing.
(5) = Very high effective
(4) = High effective
(3) = Effective
(2) = Low effective
(1) =Very low effective

This data analysis was determined to establishing the relative importance of the various factors that contribute to causes of changes and impact of changes. The chance of occurrence was rated on a scale of 1 to 5 with 1 having the lowest frequency of occurrence and 5 the highest.
The number in the filled cells indicates the number of respondents who chose that option. The last cell in each category shows the relative important index of the responses from which the major factors are listed out according to the rankings.

Relative Importance Index:-

To determine the ranking of different factors from the viewpoint of clients, contractors and consultants, the Relative Importance Index (I) was computed as:

$RII = \Sigma W / HS$

RII = Relative importance index.
W = Weighting of each factor by respondents ranging from 1 to 5.
H = Highest weight (5 in this case)
S = Sum of all respondents.
The importance of the factors according to survey responses are obtained by this method. This ranking technique was applied to Section B and Section C of the questionnaire.

A) Findings from the Analysis of Case Study No 1
This case study helps to obtain a practical picture of the impacts of changes in an on-going construction project. The increase in cost in this project is studied with reference to the construction of a pier and its foundation which was avoided from the scope of the work.
An increase in cost of Rs 353966/- was occurred due to the change of plans or scope after the construction has started. This amount may not be a large amount when compared to the total budget of the bridge, but when the element (pier) alone is

considered, there was an increase of 37.78% . According to the changed plan, the cost of construction of multiple pier upto a height of 4.95 m and its foundation is Rs 936684/- . But here, the changed plan was introduced only after the construction of foundation and pier upto a height 1.05 according to the original plan. This is the reason which caused increase in cost. This is the perfect example of how change in plans and scope of work during construction will increase the cost of project.

Next major impact of changes in this project was delay in completion of work. Total delay is more than 14 months and still the work is not complete. Only 60-65 % of the work is finished even after 36 months of commencement of project construction. The main reason of delay was prolonged process for making new drawings and approving it. This explains that decision making should be quick when a change is happened or initiated.

The removal of ramp and a pier from the scope of work didn't cause any loss for any of the parties included in the project as the work was not started when the change in design introduced.

The main reason for change in this case is change in plans or scope by the client during the construction stage. It occurred due to the lack of proper traffic study during the project definition stage. There were other impacts like pollution due to construction for prolonged period, inconvenience to the COEP campus environment and traffic congestion due to the new fly over work

B) Findings from the Analysis of Case Study No 2

The case study provides a better example of how change in an on-going construction has a direct cost and schedule impact.

The change has caused an increase in cost of Rs 151,441/- which is 0.16 % of the total estimated amount. A delay of 18 days was occurred from the planned duration which is an increase of 30% according to the schedule. When we look into the cost impacts, maximum effect is due to demolition works, which is Rs 60923.84/-. This is a case of change in scope or plans by client. From the literature review it is found as the most common cause of change. It mainly occurs due to insufficient planning in the project definition stage. Here, the client didn't consider the security reasons while planning to construct a gate in the west side of the compound. After construction, the problem was realized and decision was taken to demolish and reconstruct. This change also consumed 7 days from the total schedule of work, which was not planned.

In the case of change in design of security cabin, which caused an increase in cost Rs 40551.42/- and a delay of 10 days in starting work, the reason of change was environmental factor and differing site conditions. But this change of design by the architect is due to the lack of consideration of environmental factors during design stage. The soil condition was unforeseen as thorough geotechnical study was not done. Apart from cost and schedule impacts, the quality of the work is also reduced by this change.

The change in materials and process of water body is a beneficial change with positive impacts. It is the outcome of the timely intervention of consultant, who proposed that the change can impart cost savings and time savings. It gave a total savings of Rs 24802.77/- and 2 days. This shows that positive impacts can happen due to change if correct decision has taken during construction stage. The change in dimensions of gate is due to defect in design. It has caused an increase in cost of Rs 44853.82 /- and 2 days delay. Site location was not properly studied during design, which caused the change. Rework of paver blocks is an example of poor workmanship. Here scope of the work is not changed, but due to the decrease in quality client instructed change.

From the case study we can see that the change which caused the maximum impact was the demolition work which is due to the change in plans or scope by owner. This finding supports the literature review, which also stated the same. Other finding from the study is that positive outcome can be produced from change if timely actions have done during construction process. Other fact we can see from the analysis is that maximum time delay is occurred in the decision making process and approval of the change. This should be avoided and quick approval of the changes should be do

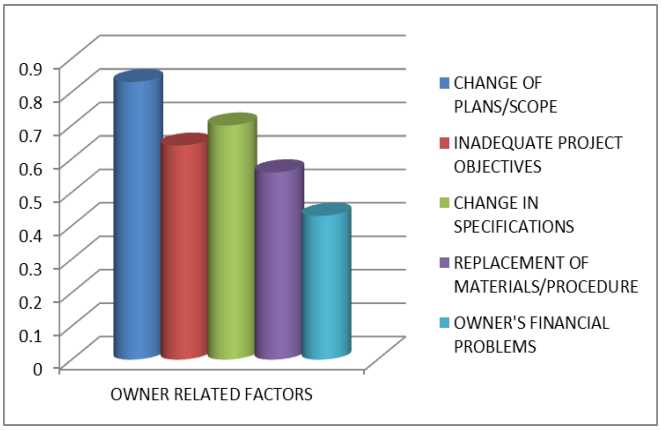

FIG 1 RII of Owner Related Factors Causing Changes.

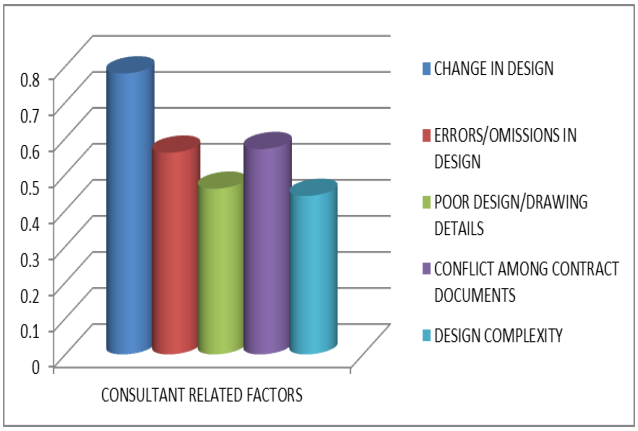

FIG 2 RII of Consultant Related Factors Causing Changes.

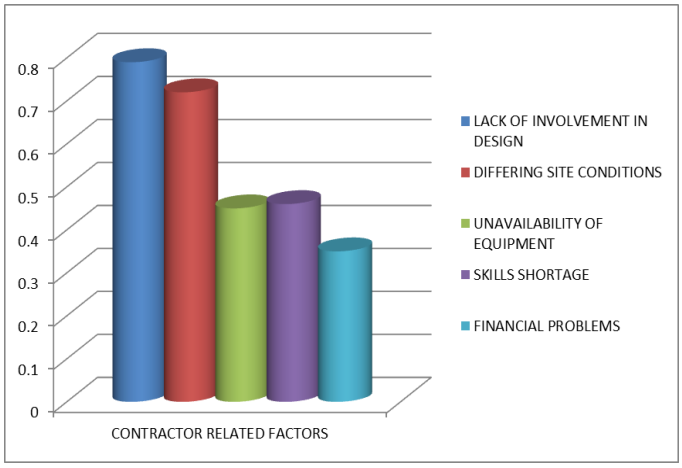

FIG 3 RII of Contractor Related Factors Causing Changes

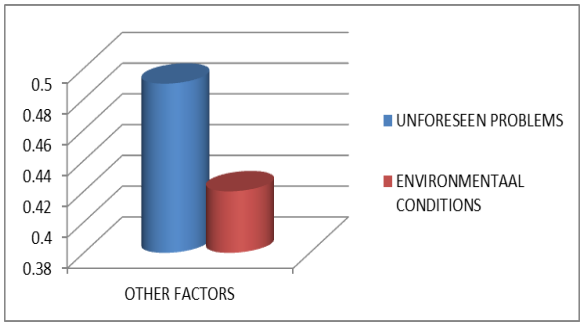

FIG 4 RII of Other Factors Causing Changes

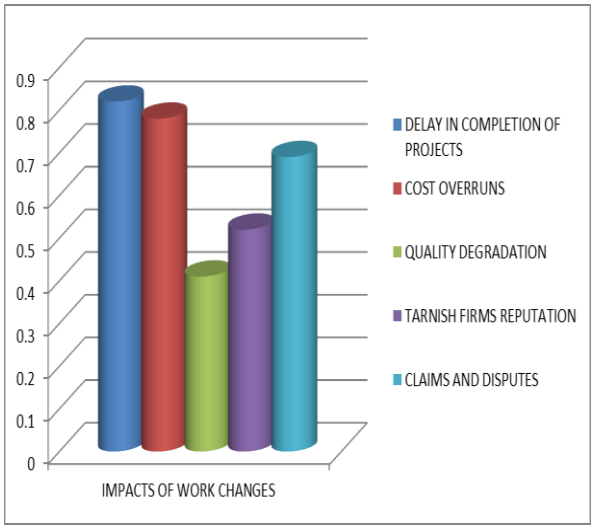

FIG 5 RII of Impacts Due to Changes

VII CONCLUSION

1. In both the case studies, the major impact of work changes was Delay in completion of work. In the first case study delay was more than 1 year, which is 50% more than the expected completion period. According to second case study, delay was 18 days, which is 30% more than the expected period of completion. From the value of RII in the analysis of Questionnaire survey, it was seen that the impact, "Delay in Completion of Projects" has got the highest i.e. 0.82. Thus it supports the fact that Delay is the major impact of change orders.
2. Out of the factors which cause changes in a construction project, "Change of Plans/Scope" by owner/client has got the highest RII value 0.83. In both the case studies, the initiating factor for major changes was Change of Plans/Scope by Client. It suggests that "Change of Plans/ Scope" as the major cause imparting work changes.
3. From both the case studies it is found that delay in approving the changed work or issuing the changed drawing is the major reason for increase in duration of work occurred due to change orders. So a swift and efficient process should be adopted to tackle the change and to issue the change order.
4. For the changes occurring due to differing site conditions and environmental factors as seen in case studies, better site study and necessary tests should be conducted.
5. From the study it is found that, in most of the cases the changes are initiated by Client. "Lack of involvement in Design" by Contractor, "Change in Design by Consultant" and "Differing Site Conditions" is other major causes inducing changes. "Delay in Completion of Projects" and "Increase in Cost" are the major impacts of change

ACKNOWLEDGMENT

I would like to thank my Guide and Head of Civil Engineering Department, Prof. Dr G.A Hinge for his vital support and assistance. His encouragement made it possible to achieve the goal.

Dr. D.V Jadhav, Principal, Bhivaribai sawant college of Engineering and Research, whose help and sympathetic attitude at every point during research helped author to work in time.

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