

Study on Change Order Impact on Project Lifecycle

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Abstract - Change orders occur frequently in most construction projects. Changes occur not only because of errors and omissions, but also for other reasons such as scope of work changes, unforeseen conditions encountered on the site. Several studies have attempted to quantify the effects of change order in the construction for project cost. The study in this area were sponsored by contactors, owner and consultant, where statistical model used to quantify the impact of the change order on the project cost. The research in this thesis is to investigate these issues in Tamil Nadu, towards developing a framework to minimize the change order at the start of the project to avoid time and cost overrun. Interviews were conducted to investigate the identified problems in more depth. The data collected are analyzed with SPSS software. A model is developed and validated to quantify the percent increase in the cost due to change orders. This model will provide the owner with an estimate of the cost of changed work; finally some recommendations and suggestions will be given to the construction industry.

Key words: *Change order, Causes and Effects of change order, Construction Projects.*

I. INTRODUCTION

The construction industry is large, volatile and requires tremendous capital outlays. Most construction projects today undergo changes at different phases due to the uniqueness of each project and limitations of time and money. A change may occur in a project due to a number of reasons such as design errors, design changes, additions to scope, or unknown conditions.

Change order can occur in every construction project and the significant of these change order varies considerably from project to project.

Change orders have long been identified to have negative impact on construction productivity. They are known to lead to decline in labor efficiency and, in some cases, sizable loss of man hours (Barrie and Paulson 1996; Moselhi 1998).

Therefore, change orders pose a serious challenge for both owners and contractors, and they frequently lead to disputes because of cost overruns. On the other hand, however, change orders provide an essential mechanism for (i) satisfying the construction needs of owners throughout a project and (ii) responding effectively to errors or omissions in design, construction methods, and contract documents. This is particularly true for fast-track construction, where construction starts prior to design completion and the scope of work is adjusted as work progresses.

II. BACKGROUND STUDY

Table 1 shows the Literature review of the study with the critical factors causing the change order.

According to Al-Dubaisi et al (2000), change in plans by the owner is the main source of change order, Errors and omissions in design is the second source of change orders. Increase in cost and duration are the two main effects of change orders.

According to Mohammed F. Al-Hams (2010), scope and quantities of work is the main source of change order, design errors is the second source of change order. Additional payment for contractor is the main effects of change orders.

According to Amine Ghanem et al (2012), decrease in quality of work is the main source of change order, disputes between owner and contractor is the second source of change order. Increase in cost is effects of change orders.

According to Alia Alaryan et al (2014), change in design by consultant is the main source of change order; change in material is the second source of change order. Delay in payment is the effects of change orders.

Table 1 Literature review

Research	Methodology	Critical Factors causing change order
Al-Dubaisi et al (2000)	21 factors identified. Categorized on the view of contractors and consultants. Data analysis by relative importance index, Prevalence Index and Utilization Index	Change of plans by owner, Errors and omissions in design, Owner's financial problems, Conflict between contract documents, Safety considerations
Mohammed F. Al-Hams (2010)	10 factors are identified. Categorized on the view of contractors and consultants. Data analysis by simulation model	Scope and quantities of work, Design errors, Differing site conditions, External conditions, Changes in design preference, Changes in market conditions
Amine Ghanem et al (2012)	50 factors identified. Categorized in the view of engineer, owner, contractor and vendor. Data analysis by simulation	Decrease in quality of work, Increase in project cost, Additional revenue for contractor, Disputes between owner and contractor
Alia Alaryanet al (2014)	20 factors identified. Categorized on the view of owner, contractors and consultants.	Change in design by consultant, New government regulation, Conflict between contract documents, Owners financial problems, Change in material

III. OBJECTIVES OF THE STUDY

The main objectives of the study are

1. To identify the major causes of issuing change orders in the projects.
2. To identify the impact of change orders on cost.
3. To develop a quantitative model of how change orders affect the cost of a project.

IV. RESEARCH METHODOLOGY

The research methodology contained fifty two (52) causes and effects of change order were identified through literature review and through discussion with some professionals involved in construction industry. A questionnaire was developed and it is consist of three main parts. Part I is related to general information for both the company and respondent. Field executives were further requested to answer questions pertaining to their experience in the construction industry. Part II and III include the list of the identified causes and effects of change order in construction project. The field executives are asked to rate the factors on five point scale for the causes and effects of change order. The scale ratings are as follows Nil, low, moderate, high, Severe. Data were analyzed using statistical tool and factors were measured and ranked using mean impact index for various constructional professionals. Finally results are obtained and suitable recommendations will be given.

V. RESULTS AND DISCUSSION

Figure 1 shows a similarity opinion in some changes orders causes between the respondents. "Weather conditions" is the first important cause with 89.3% agreement. The results also indicated that "Lack of consultant's knowledge of available materials and equipment" was ranked second with 78.6% agreement while "Change in site conditions" was ranked second with 67.2% agreement. "Contractor's desired profitability" cause of change orders was ranked fourth with 57.6% agreement. "Substitution of material or procedures" was ranked fifth 47.5% agreement. "Inadequate experience of owner's staff" was ranked last with 9.5% agreement.

The similarity opinion in some change order effects between respondents shows in Figure 2. Similar results were: "Additional payment for contractor" which is ranked first with 68.6% agreement. The results also indicate that "Procurement delay" was ranked second with 28.7% agreement while "Completion schedule delay" was ranked third with 28.1% agreement. "Quality degradation" effect of change orders was ranked fourth with 11.8% agreement. "Delay in payment" was ranked the last with 9.2% agreement.

Fuzzy logic refers to a logical system that generalizes classical two-valued logic for reasoning under uncertainty. Fuzzy set theory generalizes classical set theory to allow partial memberships. A fuzzy set is a set with smooth boundary ranging from 0 to 1. A membership function is a curve that defines how degree of membership is mapped to a membership value between 0 and 1.

The only condition a membership function must really satisfy is that it must vary between 0 and 1. The fuzzy average aggregate method is used to determine the mean of evaluator opinions by using Triangular Average Formula. The fuzzy weighted average is computed and results are shown in Fig 3.

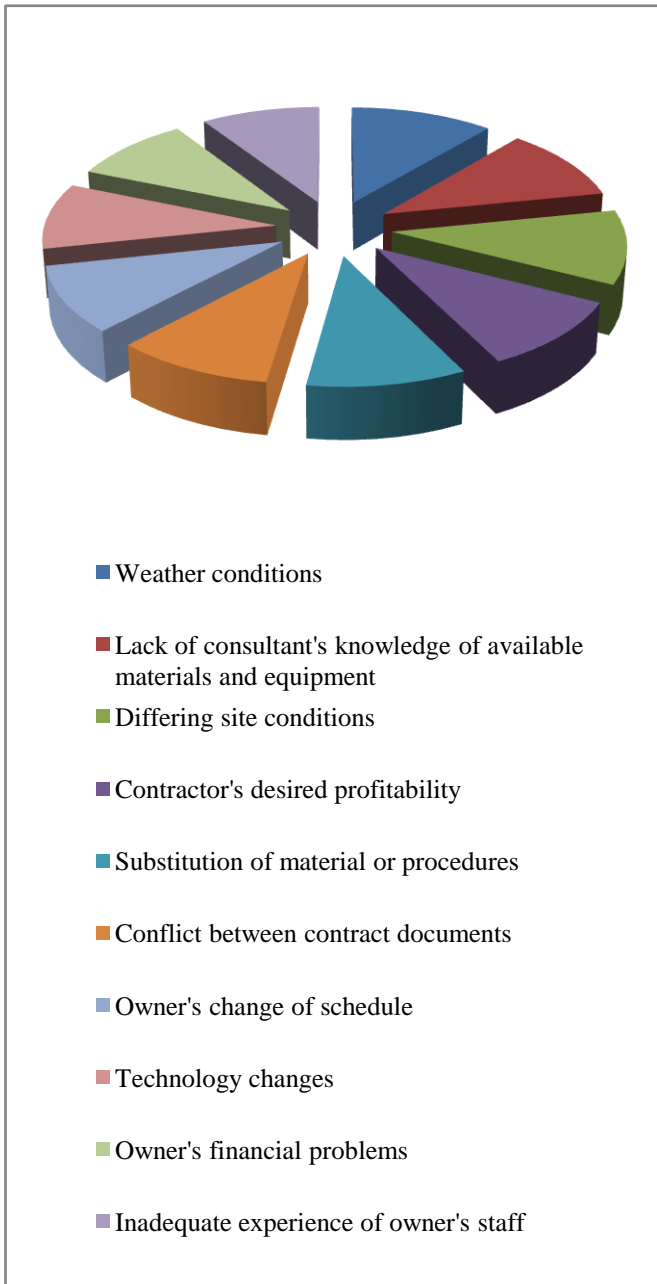


Fig 1 Causes of change order

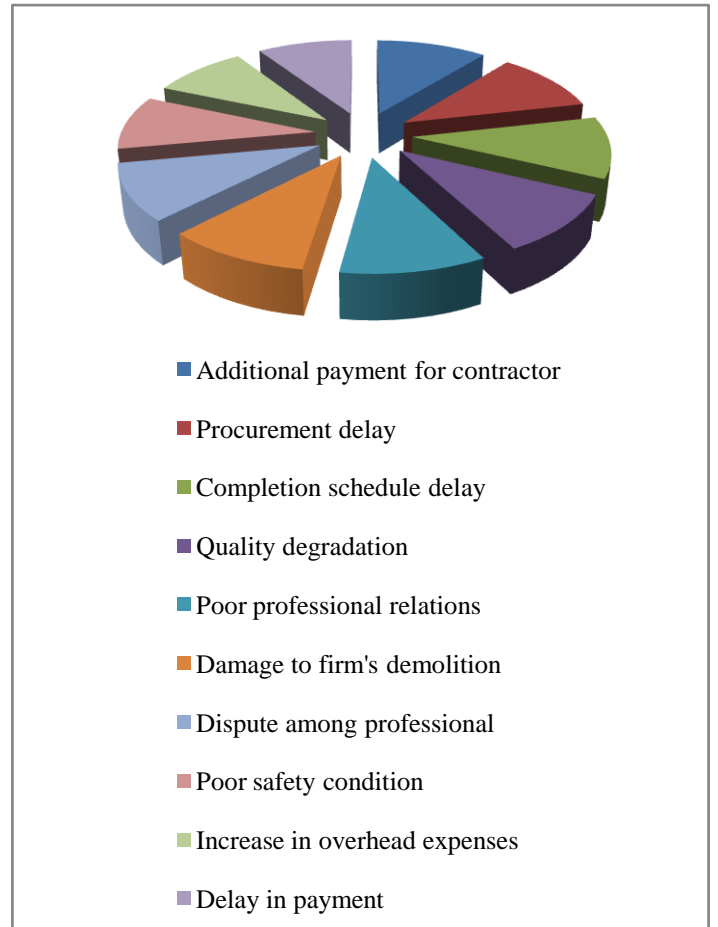


Fig 2 Effects of change order

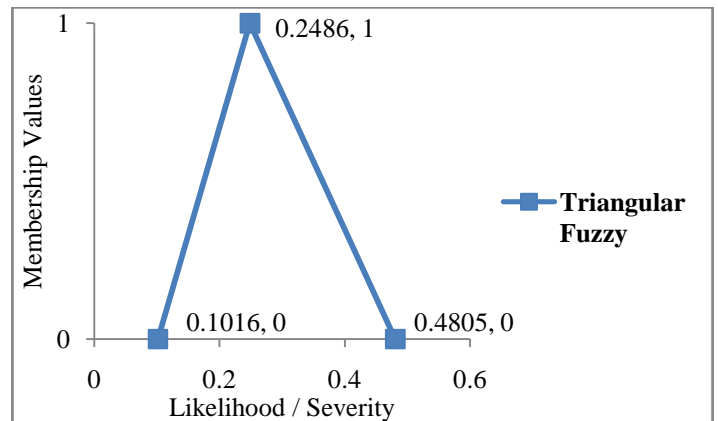


Fig 3 Triangular Fuzzy Values

A Euclidean distance formula is used for mapping the resultant fuzzy intervals back to linguistic terms. Table 2 shows the results from the Euclidean distance formula.

Table 2 Results from the Euclidean distance formula

Rating	Values	Range
Very Little	1.2769	(0-0.25)
Little	0.9711	(0-0.5)
Moderate	0.5414	(0.25-0.75)
High	0.1346	(0.5-1)
Very High	0.2359	(0.75-1)

The closest distance is 0.5414 which means that the change order from the collected sample is considered as Moderate.

VI. SUMMARY

As far as India is concerned, change order management is still a new word in the construction sector and this should be changed as soon as possible. Currently the government of India has proposed a change order rating system that will help the developers to develop projects at a faster pace by taking quick decisions. Each rating agency will have its own methodology to rate projects. This system will help government to develop a strategy to mitigate change order. This will encourage more response from developers and investors for commercial projects. It could make the bidding projects more competitive. The system will enable bankers to take quick decisions for lending finances, which could lead to the financial closure of the project at a faster pace. Third party change order rating would certainly raise critical points, which are not normally raised during finalization of the project. Construction project managers can predict the overall change order of the project before start the implementation. An overall change order index can be used as early indicators of project problems or potential difficulties. The proposed fuzzy analysis provides an effective, systematic and more natural way to analyze the associated change orders.

VII. RECOMMENDATIONS

1. Inadequate experience of owner's staff is the major source of change orders in large and medium building construction. It is recommend that the owners make adequate financial planning during planning stage to avoid changing plans later or during construction.
2. Substitution of material or procedures came as the second source of change orders and is normally originated by the owner. It is recommended that the engineer specify the material for the building in a detailed manner to eliminate the possibility of change order.
3. Change order is the additional revenue for the contractor. It is recommended that contractors educate their personnel on the negative effects of change order.
4. Contractors should expend more effort prior to contractor award to review contract document for both legal and contractual conditions as well as technical details to spot

unclear areas where conflict over its interpretation may arise. These matters should be resolved prior to the start of the construction.

5. Contractors should consider using a work breakdown structure or other tracking system more often than is used now. Many contractors indicate they not using any type of structuring system for their construction activities and this may lead to an inability to trace the effects of change orders on rest of the projects.

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