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Change Management in Electrical Installation Projects

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ABSTRACT

Change is very common thing in any project due to various factors like design change or error, extra or altered requirements, work schedule change or any unseen and unpredicted conditions which results in unfavorable conditions of project constraints, time, cost and quality. Change in projects can be considered as a risk and accordingly the mitigation techniques have to be implied to minimize its adverse implications and the process is termed as change control and management. Electrical equipment capacity and design for electricity distribution in a building depends upon civil and other utility design and energy requirement. So changes in design, plan, specification of any other facility results in major change in the electrical installation capacity and design. This study investigates the characteristics of the general electrical installation industry. Also it highlights main causes of change orders and their effects on the project. A questionnaire survey is conducted among the personals directly involved in electrical installations in a construction industry. Overall study finds that changes requested by the owner are the main cause for change order and schedule overrun is the main impact followed by budget overrun. Clearly defined scope for the change orders seems to be the common practice to control and manage the change order.

Keywords: Change Order, Electrical Installation, Causes, Effects, Controls and Management

I. INTRODUCTION

Construction industry in India is always been in focus as it is 2nd largest employer and contributor to economic development in the country after agriculture sector. So trend of fast track constructions has been developed in recent few decades to fulfil the need of growing economy. This trend results in improper planning before start of the project and necessity of modification during execution arise.

Construction of any building includes not only civil structure but also utility installations like Electrical, HVAC, plumbing, Fire-fighting, etc. Since change is an inevitable factor of any project, High Voltage and Low Voltage installation for electricity distribution in a construction project can't be an exception. Hence change orders have become very common thing in electrical installation projects. Change orders are any additive or deductive work required to be completed other than original scope of work which alters other project constraints i.e. time and cost. Change orders are initiated due to various reasons like Design changes or errors, change in work sequence, additional requirement of power or any unseen and unpredicted conditions due to project uniqueness. [1, 2]. It is a common practice to visualize a scope change as no of change orders initiated these change orders usually lead to budget and schedule overrun and disputes between the concerned entities [3]. If scope changes are not resolved by formalized scope management process becomes scope creep and ultimately reason of project failure. So it is necessary to keep track of change orders, uncover major causes and effects and implement effective control procedure to minimize effects.

II. LITRATURE REVIEW

Change orders being a regular tendency in a construction projects there are several studies discussing about

change orders, causes, its effects on cost, time, quality of work, labour productivity.

Homaid et al. [5] investigated 21 causes and 11 prospective effects of change orders. He also acknowledged 9 practices related to management and control of change orders. The study revealed 11 major causes and 7 major effects .It is further concluded that the consultant is the most responsible party for the change orders. The research also stated that change of project scope due to owner requirements is the most important cause and cost overruns are the most important impacts of change orders in those projects.

Al-Dubaisi [4] used a questionnaire survey to identify main causes of change orders and there. The author concluded that change of plans by owner is the main cause of changes while substitution of materials and/or procedures is the second source of change orders. Increase in project cost and duration were founded as the major two effects of change orders.

Diekmann et al., Fleming et al., Albalushi et al [6, 7, and 8] studied the cost overruns due to change orders in construction projects and concluded the owner is the main entity to initialize change which resulted in 5-15% cost overrun.

A Questionnaire survey conducted by Keane [9] documented causes and effects of variations on construction projects. Author also made suggestions on how deviation from original scope can be avoided or minimized in future projects.

Soares et al.[10] in his study stated that reaching negotiated solutions between the different parties engaged in the project is the best way to manage change orders, The initiation of change orders in a construction project are correlated with the degree of integration of design and execution department.

Alaryan et al. [11] investigated and analysed analyse cause and effects of change orders and effective control measures for change orders in public and private construction projects in Kuwait by a questionnaire survey of owners, contractors and consultants. The study identified five major causes, five major effects and 6 most common control measures for change orders.

The main causes of change orders in Kuwait were also studied by Bassioni et al. [12]. According to their study owners are responsible for 47% of change orders, A/E for 26% and contractor 12%. The study showed that the sources were design changes -owner 38%, design mistakes and error A/E 24%, problems on site-contractor 12% and changes by regulatory agencies 12%.

According to Hanna et al. [13] the most common reasons for change orders are additions, design changes, and errors, all of which can theoretically be eliminated in the design stage. Author also suggested that duration between the initiation of the change order and its approval should be as short as possible because if they found if the processing time is less then productivity loss is also less.

Assaf and Al-Hejji [14] conducted a survey to determine causes of delay in different types of construction projects in Saudi Arabia. They identified change orders is the most common cause of delay identified by participants of construction projects is change orders. Al-Moumani [15] and Chan et al. [16] conducted similar surveys in Jordon and Hong Kong respectively. They found that the main cause of delay in construction projects is change orders.

Change order, being a critical part of the construction projects has always been in focus. There have been several articles written on changes, change orders and change management in construction. Despite of electrical Low Voltage and High Voltage installation in a building for electricity distribution is indistinct part of a construction project, to date; there is hardly any literature available to identify specific effect of change order on electrical installations. Also the information regarding the change order process and effects have high degree of confidentiality due to completion in market. Having identified this gap it was decided to take survey of personals involved specifically in electrical installations in a construction industry. The survey is followed by analysis of change orders cause, effects and control measures which can be further used for better change management.

III. OBJECTIVE AND METHODOGY

The basic objective of the study is to investigate change orders in the electrical installation projects. Specifically it has following objectives

1. To identify most important causes of change orders in electrical installations.
2. To find out most responsible party for change order
3. To determine major effects of change order
4. To determine effective practices to control and manage change.

A questionnaire is prepared using information gathered from literature review. Specific information of general characteristics, causes, effects and control practices is taken in four different sections of the questionnaire. Section 1 include questions on general information about the projects, section 2 lists 18 causes for change orders, section three comprises of 10 impacts of change orders and section 4 contains 11 change control management process. Responses are collected from the personal who are specifically working on electrical installation in various construction projects like residential, commercial, industrial, IT, etc. The response returns are as shown in Table 1. Average response rate for the survey is 81%.

The questionnaire has ordinal scale but for further calculations it is transformed to interval scale by assigning a weight to each interval. Intervals from (never) to (very often) are assigned as an interval scale from 0 to 100. The cause, effect and controls section from the questionnaire scored as: 'VERY OFTEN' equals to (100),'OFTEN' equals to (75), 'MODARATE' equals to (50), 'SOMETIMES' equals to (25), 'NEVER' equals to (0).

The Importance index (II) for causes, prevalence index (PI) for effects and utilization Index (UI) for control measures are calculated as follows:

$$\text{II c1} = \frac{100x1 + 75x2 + 50x3 + 25x4 + 0x5}{x1 + x2 + x3 + x4 + x5} \qquad \textit{(Eq.1)}$$

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 (MODARATE)
x4 : Number of respondents answering (SOMETIMES)
x5 : Number of respondents answering (NEVER)

Prevalence and Utilization Indices will be calculated in the same way. Causes, effects, and controls will be ranked on the basis of their indexes with the first rank assigned to the highest index.

TABLE I

QUESTIONNAIRE RESPONSE

Category	Questionnaire Sent	Response Received	Response Rate %	Proportion %
Residential	15	12	80	20
Commercial	22	19	86	31
Hotel	10	9	90	15
IT	13	11	85	18
Total	75	61	81	100

IV. RESULTS AND DISCUSSION

A careful analysis of data obtained in questionnaire showed some vital findings. Fig1 shows the distribution of change orders over the different construction crafts. As can be seen from the pie diagram, major changes in the Electrical Installation in Construction Projects initiate due to civil / structural craft. From the figure we can notice that 60% change orders are from civil craft, 23% from electrical, 6% from mechanical and 11 % are from other crafts.

Average cost overrun in the electrical installation project is 17.2% of the actual contract value. The schedule overrun is shown to be in the range of 30% to 140% and the average is almost 100%. Electrical installations in IT Construction Projects has minimum schedule overrun.

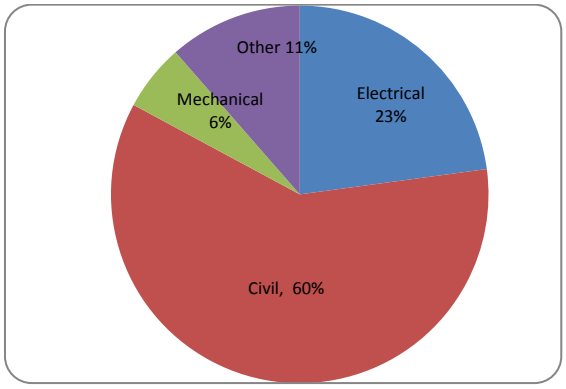

Figure 1: Change Order for Electrical Installation in Construction Projects

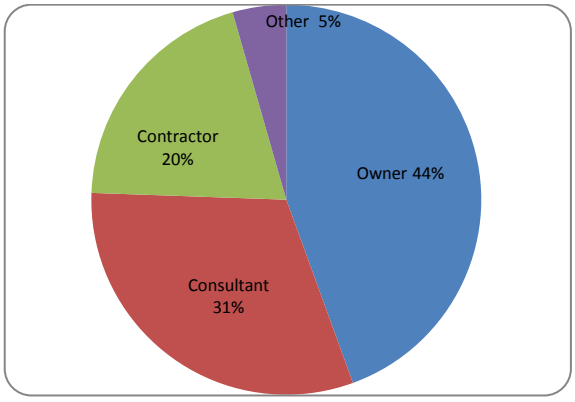

Figure 2 : Responsible Party for Change

3.1. Causes of change orders

When the average percentage of change order initiated by parties categorised, it is shown in Fig 2. From the figure it is observed that owner is the most responsible party for causing change order (44%), followed by consultant (31%). Also it is observed that no of causes whose importance index ranges between 25 to 50 is maximum i.e. 11.

Fig 3 shows relative importance indexes for causes of change order. Out of the 18 causes listed in the questionnaire five most common causes are: change of plans by owner, errors and omissions in design, change in design, substitution of materials or procedures and owner's financial difficulties.

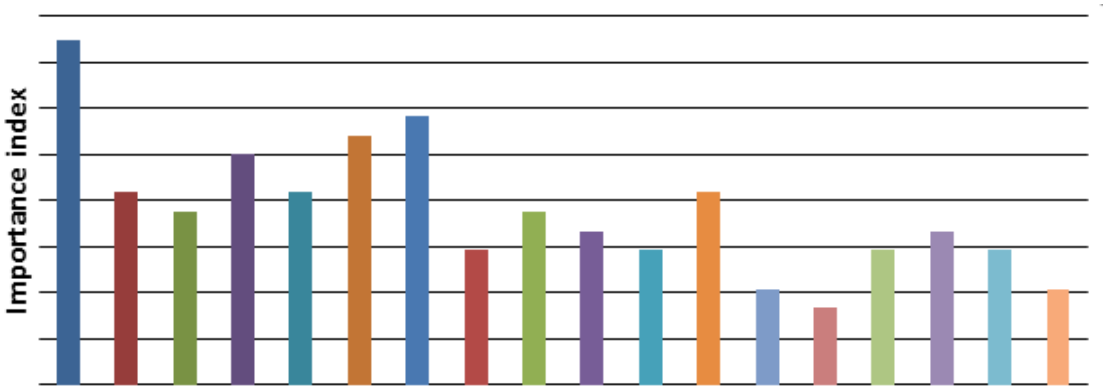

Figure 3 : Importance Index for Causes of Change Orders

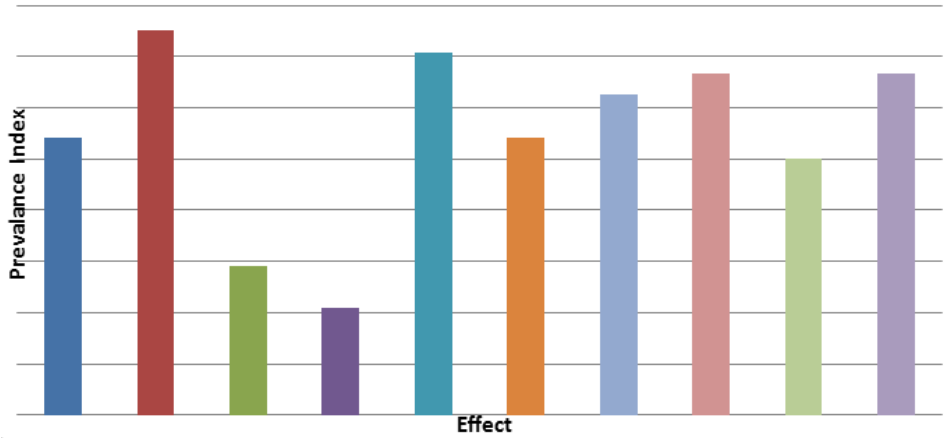

Figure 4 : Prevalence Index for Effects of Change Orders

3.2 Effects of change orders

Fig 4 shows the prevalence indexes of the change orders in electrical installation in construction projects. All respondents perceive that delay in completion schedule is most prevalent effect of change orders. Other major effects of change orders listed as increase in project cost, increase in overhead expense, demolition and rework and work on hold. Most of the effects lie in the range having prevalence index 50 to 75.

3.3 Control and Management Practices for change orders

The study examines the opinion on eleven control measures for change orders obtained in the last section of the questionnaire. Also respondents agree on the fact that that not enough is being done to control changes at primary level. So the risk of scope change resulting to scope creep is always there in a project. Accurate designing and freezing it at planning stage, use of WBS could be the best way to reduce change order but it is not practiced often. Fig 5 summarizes the utilization indexes for change control and management practices. Clearly defined change order scope is most exercised way to manage change orders. Ability to negotiate changes, appropriate approval in writing, clarity of change order procedures, justification of changes are some other methods to control and manage the schedule and budget overrun.

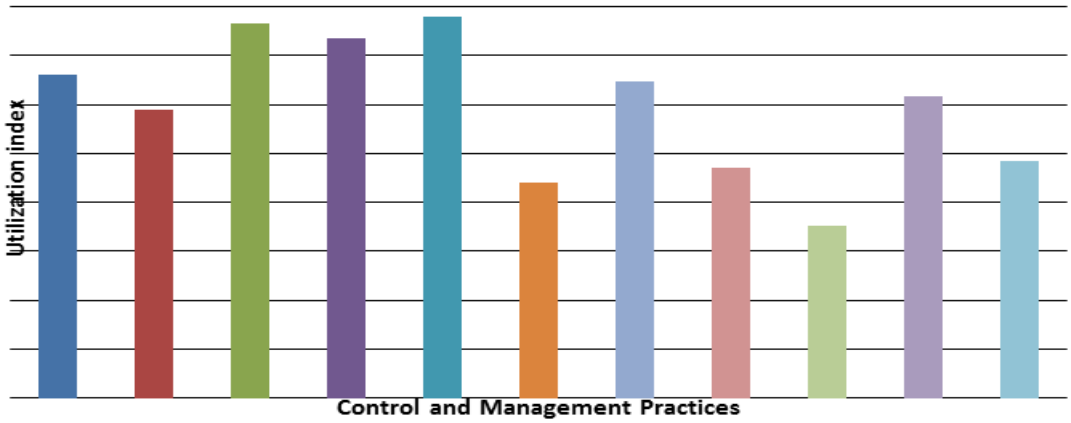

Figure 5 : Utilization Index for Control and Management Practices for Change Orders

V. CONCLUSION

Power requirement and design of the electricity distribution system in a construction project depends upon construction, HVAC, fire fighting systems, security and access control. Any change in these utilities reflects on electrical system. The causes and effects of the change orders 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 study investigates various causes and effects of change orders in electrical installation in construction projects in India. It also explores the trend of change control and management practices in the industry.

The study shows that maximum no of change orders for electrical installation is initiated by civil craft in construction project. The average budget overrun due to change orders is 17.2 % while the average schedule overrun is double the estimated time. Owner is the most responsible party for change orders. Most common causes for change are change of plans by owner, errors and omissions in design, change in design, substitution of materials or procedures and owner's financial difficulties. Major effects of change orders are delay in completion schedule

Increase in project cost, increase in overhead expense, demolition and rework and work on hold. Most utilized change control and management practices are clearly defined change order scope, ability to negotiate changes, appropriate approval in writing, clarity of change order procedures, justification of changes. Based on findings as owner is major source of change orders, extra effort in involvement of the owner from initial stage of project i.e. understand the design would minimize the changes made by the owner. Also adequate financial planning

should be done by the owner to avoid change in schedule later because of insufficient funds. The designs should be accurate and specifications of the procedures and materials should be clarified at earlier stage of the planning to minimize impact of causes initiated by consultants. Contractors should consider using a Work Breakdown Structure or other tracking system more often than is use.

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