To Study and Analyze Different Causes of Delay in Construction Projects: A Review

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Abstract: Construction delays are common problems in civil engineering projects. These problems occur frequently during construction phase. Therefore it is essential to study and analyze different causes of delays in construction project. The aim of this paper is to study the classification of delays which occur in various parties like owner, consultant and contractor during construction projects. The aim of this paper to study current various techniques used to minimize delays in the construction projects and also study delay analysis techniques used for claim purpose. The paper also focuses on statistical tools used to identify important causes of delays in construction projects.

Key Words: Causes, Construction Projects, Delay.

1. INTRODUCTION

Any construction project must be executed within optimum duration and estimated cost to minimize delay and cost overrun of project. In India in 2005, 646 national projects were being executed, out of which 40% of project were behind the schedule due to improper planning, management, fund, unskilled workforce etc. Project completion within time is major challenge in construction. In various cases, delays always contribute to time and cost dispute and miscommunication between participant within project such as clients, consultant, contractor, subcontractor and suppliers according to Al-Khalil and Al-Ghafly in 1999\cite{2}. Delays happen either in simple or complex project due to inadequate labour force, material, equipment problem, weather condition, improper scheduling and planning and fund availability etc. To minimizedifferent causes of delay in construction projects, proper scheduling methods are to be adopted; also proper communication between owner, client, contractor, sub-contractor and engineer during construction phase must be maintained.

1.1 Objectives of study

The main objectives of this study include the following:

1) An in-depth review of the literature related to project delays.
2) To study the classification of delay in construction projects.
3) To study delay analysis techniques to identify different causes of delay in construction projects and to study delay minimizing techniques.
4) To study the statistical tools to identify most importance causes of delay.

1.2 Delay studies

In 1971, Baldwin and Monthei\cite{5} did research to analyze delay in building projects in United States. They surveyed a number of different parties involved in building project like engineers, architects and contractors and found that there was agreement between these three groups concern to the causes of delay. They also observed that sub-contractor, weather and labour supply also contributed majorly to the causes of delay. In 1984, Chalabi and Camp \cite{7} studied various causes of delay within building project in developing countries during pre-planning and construction stage. They also identified that planning was most important at early stage of project for minimizing delay and cost-over run in most of the building projects in developing countries. In 1996, Ogunlana\cite{13} conducted survey in Thailand, Bangkok. According to their observation delay were divided in to three major groups. 1) Problems of resources or shortage or inadequacies in the industry infrastructure. 2) Problems caused by clients and consultants. 3) Problems caused by contractors.

In 1997, Chan and Kumaraswamy\cite{8} did research to analyze delay in hongkong construction projects. They found five major factor contributing to delay. 1) Poor risk of supervision and management. 2) Slow
decision making, 3) Work variance, 4) Unfocused site condition, 5) Client-initiated variation. Mansfield in 1994 [10], studied causes of delay and cost-over run in Nigerian construction projects. He found delays happen due to five major factor, 1) Poor construction management, 2) Inaccurate estimation, 3) Over all prize fluctuation, 4) Shortage of material and equipment, 5) Finance and payment agreements. In 2000, Al-moman [3] conducted survey to investigate main causes of delay related to design, weather, user changes, site condition, late deliveries, increase in quantity and economic condition and also studied various factors which help to minimize contract disputes.

1.3 Definition of delay
In construction industry delays are most common problem occurred in normal as well as complex projects. In construction project, a delay can be defined as overtime completion of construction work compared to the scheduled. According to Sanders and Eagles (2001) [16], “delay is defined as an event that causes extended time to complete all or part of project.” According to Bramble and Callahan (1987) [6], “delay is the time during which some part of construction project has been extend or not performed due to an unexpected circumstances”

1.4 Classification of delay
In construction project delay happens due to various factors. According to Ahmed et.al., (2003) [1], delays are grouped into two categories. First one is internal causes of delay and second one is external causes of delay. Internal causes of delay arises due to involvement of contractor, client and consultant and external causes of delay were evolve of event beyond the control of the parties like the act of god, government action and material supplier. Classification of delay as follows [9], [12].

![Figure 1. Classification of delay](image-url)
2. DELAY MINIMIZING METHODS

From literature various project control methods used for minimizing delay in construction project are mentioned below:

1) Critical path method is a planning technique, which is normally used for activities and resource planning. The CPM helps to identify the possible critical activities in a construction project that are affected by critical resources. If some of the activities require other activities to finish before they can start, then the project becomes a complex task to identify critical activities. CPM helps to establish how long your complex project will take to complete and which activities are ‘critical’ meaning that they have to be done on time or whole project will be delayed.

2) Scheduling resource allocation is a technique to collect all resources of particular activities which are needed during construction phase on time, otherwise project delays may occur due to resources not available within time during construction.

3) Earn value analysis is a measuring tool, which is a combination of critical path method and scheduling resource allocation. Earn value analysis is an industry standard methods to evaluate how much work has to be completed within time and how much resources are consumed for this work. With the help of this analysis it helps to identify project progress i.e. on schedule or behind the schedule at any given point of time. Earn value analysis gives forecasting of completion date and final cost and also it helps to analyzing variances in the project proceeds.

From the various research papers also mention, a number of delay minimizing methods are to be used in construction projects like accurate initial project cost estimated, proper utilization of the modern construction technology, frequent site meeting with all parties, perform a preconstruction planning of project tasks and resource needs, selection of a competent consultant and a reliable contractor to carry out the work, allocation of sufficient time and money at the design phase, ensure adequate and available source of finance until project completion, Hire an independent supervising engineer to monitor the progress of the work, development of human resource management, timely decision making by all functional group, early in obtaining permit and approval from relevant authority, built a systematic project control and monitoring mechanism, absence of bureaucracy, accurate initial time estimation [11][20].

3. DELAY ANALYSIS METHODS

Pablo Gonzalez et. Al.[14] studied different project analysis techniques are 1) as-planned versus as-built method, 2) global impact technique, 3) as-planned technique, 4) impacted as-planned technique, 5) net impact technique, 6) time-impact analysis technique, 7) but-for, 8) isolated delay-type technique, 9) snapshot technique, 10) windows analysis, and 11) simulation used for claim analysis. From the literature, four methods are widely used for analysis of delay in construction project which are mentioned below:

1) as-planned vs as-built method is an observation method in which the difference between as-planned schedule and as-built schedule is highlighted. The method identifies the as-built critical activities compare these activities with other activities on the as-planned schedule. This method also identifies the sequences which actually define the duration of project and also determine the responsible parties and causes of delay in construction projects [4].

2) Impact as-planned method is only used for as-planned or baseline schedule for delay analysis. This is based on the theory that earliest date by which project is completed can be determined by adding the delays into the as-planned schedule. The delays caused by either contractor or owner are added to the as-planned schedule, and delay impact on the project duration is evaluated [19].

3) Collapsed as-built method is also known as “but for “schedule method. This analysis is popular in claim presentation because it is easily understood by triers of facts and can determine delay impact in case of
limited time and resources available for analysis. This method is used when contractor lacks on acceptable schedule during the project or when as planned schedule was required in contract [4].

4) Time impact analysis is based on critical path method principle, it assesses delay effects on project schedule by analyzing the schedule generally on day-by-day basis. Window analysis, a variation of time impact analysis, uses a weekly and monthly updates to perform the analysis. Delay events or activities inserted into the project schedule and delay impact are evaluated every time the schedule is again calculated [4].

4. STATISTICAL TOOLS TO IDENTIFY MOST IMPORTANCE CAUSES OF DELAY

Alwiet.al.,(2003)[18] identified the main causes of delay in building construction projects in Indonesia. From literature they evaluated causes of delay related to people, professional management, design, documentation, material, execution and external causes of delay. With the help of questionnaires, survey was conducted between large contractors and small contractors on projects that had completed within the last five years. The interviewees included project manager, site managers, supervision, foremen and labourers. Data collected was analyzed using importance index and ranking was done by spearman's rank correlation coefficient. Alwiet. al.,[18] identified the importance of delay causes on multi-storey buildings in Indonesia. Also there was a greater similarity between large and small contractors towards individual causes of delay. Whereas there was little similarity in relation to ranking the groups of delay variables. This paper focuses to identify important causes of delay which to take preventive actions and plan accordingly in order to keep the construction projects on schedule.

Saudi A. Assaf and Sadiq Al-Hejjj[15], Studied causes of delay in large construction project. From literature it is evaluated that there are 56 main causes of delay in large construction project. Delay factor was divided into nine groups, 1) project, 2) owner, 3) contractor, 4) consultant, 5) design team, 6) materials, 7) equipment, 8) Manpower, 9) external factors. From above nine groups causes of delay in large construction projects are identified.

A questionnaire was prepared to evaluate frequency of occurrence, severity and importance of the identified causes. Also rank is given by each identified causes of delay with the help of spearman rank correlation coefficient. Field survey was conducted with the help of contractors, consultants and owners. From collected data Saudi A. Assaf et al, [15] identified only one cause of delay is common in all parties which was 'change order by owner during construction'. Many causes are common between two parties which are stated below are shortage of labor, difficulties in financing by contractor, delay in progress payment, ineffective scheduling and planning by contractor. Also he observed that all parties give least importance to change in government regulation, traffic control, site condition and accident during construction. For data analysis statistical techniques and indices as follows:

1) Frequency index: A formula is used to rank causes of delay based on frequency of occurrence as identified by the participants.

\[
\text{Frequency Index (F.I.) \%} = \frac{\sum a(n/N)}{\text{100/4}}
\]

Where \(a\) is the constant expressing weighting given to each response (ranges from 1 for rarely up to 4 for always), \(n\) is the frequency of the responses, and \(N\) is total number of responses.

2) Severity index: A formula is used to rank causes of delay based on severity as indicated by the participants.

\[
\text{Severity index (S.I) \%} = \frac{\sum a(n/N)}{\text{100/4}}
\]

Where \(a\) is the constant expressing weighting given to each response (ranges from 1 for little up to 4 for severe), \(n\) is the frequency of the responses, and \(N\) is total number of responses.

3) Importance index: The importance index of each cause is calculated as a function of both frequency and severity indices.

\[
\text{Importance index (IMP.I) \%} = \left( \frac{\text{F.I. (\%)} + \text{S.I. (\%)}}{2} \right) / 100
\]
4) Spearman’s rank correlation: The Spearman’s rank correlation coefficient $r$ is used to measure and compare the association between the rankings of two parties for a single cause of delay, while ignoring the ranking of the third party. And it is calculated by the following formula:

$$r = 1 - \frac{(6 \sum d^2)/(n^3 - n)}$$

The correlation coefficient varies between +1 and -1, where +1 implies a perfect positive relationship (agreement), while -1 results from a perfect negative relationship (disagreement).

According to Shubham Vyas, [17] delay in industry or project construction is one of the major barriers of developing countries such as India, China and most of south east countries. He conducted questionnaire survey which consist of two parts, 1) basic questions regarding projects and background of the project, 2) factors of delays categories into ten different groups like employ, materials, time management, safety, risk management, equipment, external causes, finance, engineering and daily targets. He adopted a method derived by Chan and Kumaraswamy in 1996; Lew et al., 2003- conducted a survey to determine mean variance causes and effect of delay. For data analysis mean variance technique as follows:

$$\text{Mean}= \frac{1}{N} \sum (f \times s)$$

“$f$” refers frequency, “$s$” refers is the score given to each factor by the respondents and “$N$” refers total no. of respondents. Data collected from field main causes of delay occurred in project construction are categories as follows: 1) lack of daily targets, 2) lack of strategic planning, 3) quality material get damage due to poor storage area, 4) decision making power, 5) team work and co-ordination.

5. CONCLUSION
After reviewing the literature it is concluded that delay in construction projects is major problem for construction industry which mainly affect the time and cost-over run of the projects. Also the paper highlights various methods used to minimize delay in construction projects and also various delay analysis methods used to identify the different causes of delays in construction projects.

REFERENCES


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