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Delay in Construction of Highway and Expressway Projects

Vijay Kumar

M-Tech final year in Construction Management
SUBHARATI INSTITUTE OF TECHNOLOGY & ENGINEERING, MEERUT (U.P.) 250005 INDIA

Abstract – *The construction industry is one of the main sectors that provide important ingredients for the development of an economy. However, many projects experience extensive delays and there by exceed initial time and cost estimates. Construction delay is considered to be one of the most recurring problems in the construction industry and it has an adverse effect on project success in terms of time, cost, quality, and safety.*

Highway and Expressway projects in India are affected with enormous delays. Over the last decade, as a result of paradigm shift in the volume and capacity of the highway construction sector, it is very important to systematically analyze the factors of delays and to build up a concise understanding amongst the highway and expressway professionals. Adopting a comprehensive project stakeholders' analysis namely client, consultant and contractor, the research identified the important factors affecting the delays in Indian highway and expressway construction industry and then establishing the association between factors to develop the prediction models to assess the impact of these delay factors. A questionnaire survey and personal interviews methodology was used for this research. Most critical variables causing construction delay were analyzed using factor analysis. These results will significantly contribute in controlling the time overruns in Indian highway & expressway construction industry. This project delays forms a challenge for developing countries like India, where exponential costs result from difficulty in recognizing and mitigating the project delay factors. This research focuses on prominent factors causing delays in highway & expressway construction industry, and accordingly proposes a suggestive framework to design a construction project in an efficient manner and assisting mitigating of delays.

Key Words: Development, Concise, Enormous delays, Paradigm, Framework analysis, Factor analysis, Conceptual framework, Exponential, Mitigating.

1. INTRODUCTION

Roads are an important mode of transport of India and having the one of largest road network across the world, spanning over a total of 5.89 million km. of roads. This road network transports 69 per cent of all goods in the country and 90 per cent of India's total passenger traffic uses road network to commute. Road transportation has gradually increased over the years with the improvement in connectivity between cities, towns and villages in the country and In India sales of automobiles and movement of freight by roads is growing at a rapid rate.

NHAI has accomplished construction of 3,979 km of national highways in the financial Year 2019-20. This is the highest ever highway construction achieved in a financial year. The construction pace as noticed in last years has seen a steady growth with 3,380 Km construction in the FY 2018-19. Continuing the same trend with the development of 3,979 km of national highways during FY 2019-20

The Government of India has set a target for construction of 12,650 km national highway in FY: -2020-21. Huge investments have been made in the sector with total investment increasing more than three times from Rs 51,914 crore in 2014-15 to Rs 170,000 crore in 2020-21(Allotted the fund in this sector).
India has a well-developed framework for Public-Private-Partnerships (PPP) in the highway sector. Asian Development Bank ranked India at first spot in PPP operational maturity and also designated India as a developed market for PPPs.

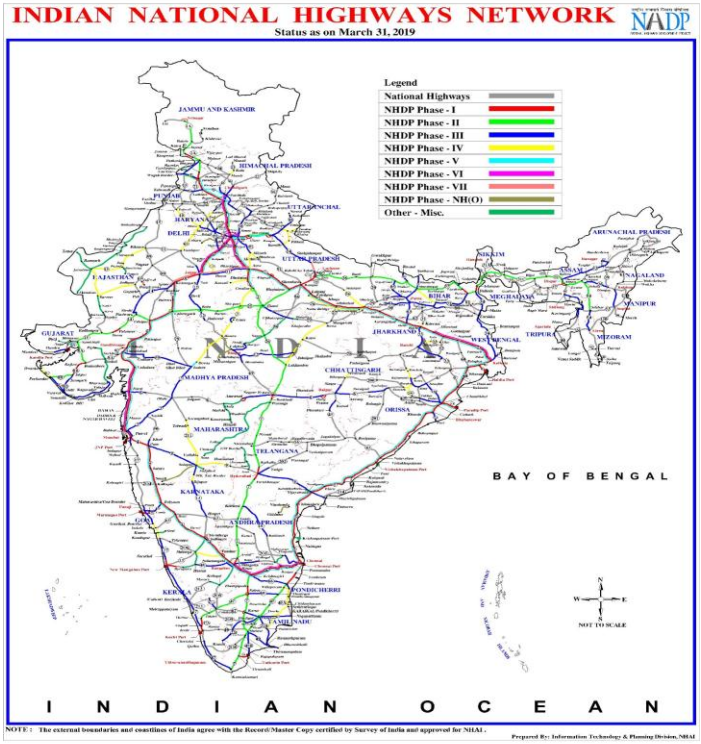
The Government of India (GoI) is planning to expand the national highway network to over 200,000 km. The Government launched the Bharatmala Pariyojana, which aims to build 66,100 km of economic corridors, border and coastal roads, and expressways to boost the highway network. It is envisaged that the programme will provide 4-lane connectivity to 550 districts, increase the vehicular speed by 20-25% and reduce the supply chain costs by 5-6%. The first phase of the programme will bring in $ 82 bn investments by 2022 for the development of 34,800 km of highways.

The government has forecasted an investment of $350 bn towards road infrastructure in the North-East region of India during 2020-2025.

The market for roads and highways is projected to exhibit a CAGR of 36.16% during 2016-2025, on account of growing government initiatives to improve transportation infrastructure in the country. Almost 40% (824) of the 1,824 PPP projects awarded in India until December 2019 were related to roads.

The highway construction industry is one of the main sectors in India that provide important ingredient for the development of an economy.

However, many projects experience extensive delays and thereby exceed initial time and cost estimates. Construction delays are considered to be one of project success in term of time, cost, quality, and safety.



2. Delays

The timely completion of road infrastructure projects is an important objective. A significant annoyance to the public occurs when projects are not completed in a timely manner and when actual progress of the construction work is longer than necessary, thereby prolonging the inconvenience and disrupted business access. Economic & social welfare, and safety are all related to timely completion. In spite of the importance of timely completion, construction delays remain a common occurrence. This paper addresses the significant causes and factors of delays in road infrastructure projects and how one can predict the completion date for the project using earned value management.

The Construction delay may be defined as the time overrun either beyond completion date specified in a contract, or beyond the project delivery date as agreed by parties defined delay as an act or event which extends required time to perform or complete work of the contract manifests itself as additional days of work.

Delay in construction of highway/expressway projects, had a significant impact on economic activities in the country. Several highway and expressway constructions projects have littered the length and breadth of the country for which government has commenced that has yet to be completed. Unfortunately, the time line for these projects is unknown to the citizens of the country. This has led to an increased number of uncompleted road construction projects by Indian Government.

The cost of a construction project is one of the most important factors in the construction industry. Due to many reasons, the total cost of a project can significantly vary from the initial estimated cost. The reasons could be changes in scope of work, specifications, or any other contract documents. In the construction industry, variation orders are created when changes occur. It is an official document that states the changes made into the original agreement between the client and the contractor. When a variation order is created, it brings several negative effects to both the client and the contractor.

The construction industry is the tool through which a society achieves its goals of highway and expressway development. It is one of the sectors that provide important ingredients for the development of an economy.

3. Types of Delay: -

Delays in construction of highway/ expressway projects have been put in various classifications by several authors but most of these classifications have a lot in common in terms of their fundamentals. Although various types of in several studies, they are somewhat linked to one another. These class have been elaborated in the arguments below.

Most importantly, delays can be seen in these four major categories as mentioned below: -

1. Critical and Non-Critical.
2. Excusable and Non-Excusable,
3. Compensable and Non-Compensable
4. Concurrent and Non-Concurrent.

1-Critical delay and Non-Critical Delays: -

As indicated earlier in the above classification of delays as portrayed by Bolton J. this set of delay classification has some connection with previous ones. Critical delays are delays which prevent the contractor from finishing the work on the scheduled completion date as agreed upon in the contract as well as client are unable to handover the hindrance free site and required land to the contractor during appointed date. This concept has roots entrenched in the Critical Path Method (CPM) schedule which helps identify the critical activities in a construction of highway /expressway project. All projects have critical activities embedded in their execution irrespective of the kind of schedule being run. These critical activities are sometimes referred to as the controlling item of work. CPM seeks to accomplish following main objectives: -

• To calculate the project's completion date

• To calculate the project's completion date

• To identify the extent to which each activity in the schedule could slip without delaying the project.

• To identify which activities in the schedule would have the highest risk of affecting the project completion date if they slipped.

How is the CPM used to estimate the project's finish date? There are basically two methods of estimating the project's date using the CPM, the Forward Pass Calculation and the Backward Pass Calculation. The Forward Pass computes the early start and the early finish dates of the project whiles the Backward Pass estimates the late start and the late finish dates. That notwithstanding, identifying

which activities truly impact the completion date of the project also depends on the following factors as given by Trauner (2009):

• The project itself

• The contractors plan and schedule (particularly the critical path)

• The requirements of the contract for sequence and phasing

• The physical constraints of the project – how to build the job from a practical perspective.

It is important to note that irrespective of how one chooses to analyze a construction project schedule to identify delays; there will always be an overriding factor which will need much attention. This is known as the contemporaneous information which refers to the daily reports, the schedules in effect and any other job data available to reflect the existing situation at the time of the delay (Trauner,

2009). From the above explanation, non-critical delays can be seen as those delays that do not impact the completion date of the project but in a way, affect the progress of the work. It can therefore be said that both excusable and non-excusable delays are all critical delays. This leaves non critical delays as a standalone delay classification.

2-Excusable Delays and Non-Excusable Delays: -

2.1 Excusable Delays: -

Excusable Delays is a delay that is due to an unforeseeable event beyond the contractors or the subcontractor's control or client's control. Normally, based on common general provisions in public agency specifications, delay resulting from the following events would be considered excusable:

• General labor strikes.

• Fires.

• Floods.

• Acts of God.

• Owner- directed changes.

• Errors & omissions in the plans and specifications.

• Differing site conditions or concealed conditions.

• Usually sever weathers.

• Intervention by outside agencies.

• Lack of action by government bodies, such as building inspection.

Before the analyst concludes that a delay is excusable based solely on the preceding definition, he or she must refer to the construction contract documents. Decision concerning delays must be made within the context of the specific contract. the contract should clearly define the factors that are considered valid delays to the project that justify time extensions to the contract completion date, for example some contracts may not allow for any time extension caused by weather conditions, regardless of how unusual, unexpected, or sever.

2.2 Non-Excusable Delays: -

Non-excusable delays are events that are within the contractor's control or that are foreseeable. These are some example of non-excusable delays: -

• Less-experienced & incompetent manpower engaged.

• Inadequate resources (Manpower and Machinery) engaged.

• Delay in staff (Permanent/Contract) salary, Daily wedges labour payment.

• Delay in Vendor (Sub-contractor, Supplier and design consultant) Payment.

• Frequently leaving the project by contractor's staff including top management.

• Less-experienced & incompetent design consultant (including Survey & Geotech work) engaged for design the highway/expressway.

• Inadequate major material provided by supplier.

• Faulty selection of the vendors.

• Untimely performance by suppliers.

• Late performance of subcontractors.

• Faulty workmanship by the contractor and subcontractors.

• A project specific labor strike caused by either the contractor's unwillingness to meet with labor representatives or by unfair labor practices.

Non-excusable delays are events that are within the Client/Consultant control or that are foreseeable. These are some example of non-excusable delays: -

• Delay in handover the required Right of Way (ROW) to Contractor.

• Delay in Land acquisition and unable to handover timely.

• Delay in Approval of Electrical Estimates for shifting the Electrical poles and lines timely.

• Delay in Permission of Tree Cutting from Forest Department.

• Delay in Environment Clearance from Environment Department.

• Delay in removal of hindrance like school, house, temple building, boundary wall etc.

• Delay in shifting of gas pipe line, optical fiber Cable, & other utility shifting etc.

• Delay in decision for Additional work/Underpasses under Change of scope during execution demanded by local users.

• Delay in approval of General Arrangement Drawings (GADs) of Rail Over Bridge/ Rail under Bridge (ROBs/RUBs) as well as completed design and drawings from Railway Department.

• Delay in approval of design and drawings from Client/Consultant.

• Delay in Sources approval from Client/Consultant.

3-Compansable or Non- Compensable Delays: -

A compensable delay is a delay where the Contractor is entitled to a time extension and to additional compensation. Relating back to the excusable and non-excusable delays, only excusable delays can be compensable. A non-compensable delay means that although an excusable delay may have occurred, the contractor is not entitled to any added compensation resulting from the excusable delay. Thus, the question of wheatear a delay is compensable must be answered. Additionally, non-excusable delay warrants neither additional compensation nor a time extension. Whether or not a delay is compensable depends primarily on the terms of the contract. In most cases, a Contract specifically notes the kinds of delays that are non-compensable, for which the contractor does not receive any additional money but may be allowed a time extension.

4-Concurrent or Non- Concurrent Delays: -

Concurrent delays like most other delays have several definitions as put forth by practitioners in the industry. A few definitions as prescribed by the Association for the Advancement of Cost Engineering (AACE) (Recommended Practice 10S-90) have been considered below;

• Two or more delays that occur or overlap within the same period, either of which occurring alone would have affected the ultimate completion date.

• Where two or more independent causes of delay occur during the same time period. The same time period being referred to is not always literally within the exact period of time but can be elated by circumstance, even though the circumstance may not have occurred during the exact same period.

• True concurrent delay is the occurrence of two or more delay events at the same time, one an employer risk event, the other a contractor risk event and the effects of which are felt at the same time.

Concurrent delay mostly refers to the situation where two or more delay activities occur at different times but the impact is felt (in whole or in part) at the same time. It occurs when both parties to the construction contract (owner and contractor) delay the project during an excusable but non compensable delay (such as severe weather conditions). Such delays do not necessarily have to occur simultaneously but can be on two parallel critical path chains. Concurrent delays may also be an excusable delay with compensation which may grant some reliefs to the contractor in the form of extension of time, remission of liquidated damages and sometimes potential delay of damages subject to the given circumstance and the contractual agreement. In the same vein, a concurrent delay may also be inexcusable where the delay of the contractor, though concurrent with that of the owner, had a more severe impact on the finishing date. For instance, the owner's delay occurred from the 5th to the 8th month of the project period while the contractors delay was from 4th to the 10th of the project period. Though these two delays happened around the same time, the contractor's delay would impact the completion date rather than the owners.

Concurrent delays could be caused by the delaying effects of events that were either excusable (i.e. the events for which the employer takes the risk of time and for which extensions of time should be granted to the contractor) or culpable (i.e. events for which the contractor takes the risk of time) (Rawlings, 2003). However, the effects of two delaying events by both parties to the contract, which impacted upon progress of the contract at mutually exclusive time frames, could not be said to be concurrent.

4. Delay Factors: -

There are several causes or factors of delays that have been identified by researchers in the field of project management in the highway construction industry. Some of these researchers have even attempted to categorize the causes of delays based on certain factors. These categories may have some geographical limitations and as such cannot be applied using a wholesale approach. This probably explains why there are several researches on the causes of delays in construction projects from several countries. Although there are some similarities in these findings, the differences reiterate the need to have geographic dimension to this subject matter. Some causes are major whiles some are minor in their prevalence as observed by various researchers hence, those who attempted classifying the causes based them on the ones identified by stakeholders as very pervasive in nature.

A number of studies have been conducted in regard to delays in construction projects for decades with scholars advancing various factors and groups of factors that contribute to causing delays. Available literature reviewed indicate categorization of the various factors in groups of up to eleven categories of consultant-related, contractor - related, design-related, equipment-related, externality - related, labor-related, material-related, owner-related, project-related, engineer-related and human behavior related among others. This study however re-clustered these factors into four broad categories of client-related, consultant-related, contractor-related, and external-related factors: -

4.1-Client Related Delay Factors: -

Several studies have identified owner related delay factors to cause schedule delays. Client related factors are as under: -

- Delay in handover the required Right of Way (ROW) to Contractor.
- Delay in Land acquisition and unable to handover timely.
- Delay in Approval of Electrical Estimates for shifting the Electrical poles and lines timely.
- Delay in Permission of Tree Cutting from Forest Department.
- Delay in Environment Clearance from Environment Department.
- Delay in removal of hindrance like school, house, temple building, boundary wall etc.
- Delay in shifting of gas pipe line, optical fiber Cable, & other utility shifting etc.
- Delay in decision for Additional work/Underpasses under Change of scope during execution demanded by local public.
- Delay in approval of General Arrangement Drawings (GADs) of Rail Over Bridge/ Rail Under Bridge (ROBs/RUBs) as well as completed design and drawings from Railway Department.
- Poor communication and coordination between client and other local departments.
- Slowness in decision making process by owner, conflicts between joint ownership.
- Unavailability of incentives or Client doesn't to give incentive for contractor for finishing ahead of schedule.
- Delay in making progress payments by the client as critical.
- Corruption has a serious impact on construction delay.
- Delay in finalization and mobilization of Consultant.

4.2-Consultant Related Delay Factors: -

The literature review was done through books, engineering journals, conference papers, masters and academic theses, the internet, and interview with experts from the highway construction industry to identify factors that are responsible for delays in delivering construction projects globally. Several studies have identified consultant related factors to cause schedule delays as mentioned below: -

- Delay in approval of design and drawings by Consultant.
- Delay in Sources approval by Consultant.
- Delay in technical decision approval of site during execution by Consultant.
- Less/un experienced & incompetent manpower engaged at site.
- Late issuance of instructions and inadequate supervision critically impacted by Consultant.
- Delay in performing inspection and testing by consultant.
- Inadequate site inspection as the main causes of the consultant.
- Late recommendations of RA Bill for payment.
- Poor coordination between site office staff and design team (HO/CO).
- Identified delays in approving major changes in the scope of works by Consultant.
- Inflexibility (rigidity) of consultant regarding technical concern without consideration of any latest specifications.
- Conflicts between consultant and design engineer, inadequate experience of consultant.
- Egoistic behavior with contractor staff during work.
- Non linking of progress with their wedges.
- Fixed the duty time of site staff.
- Corruption has a serious impact on construction delay.

4.3-Contractor Related Delay Factors: -

Available literature contends that proper project planning, availability of materials; equipment and adequate labor are key critical success factors for the successful implementation of highway/expressway construction projects. A number of studies have been carried out in those key critical dimensions in order to assess their relative contributions to schedule delays in the construction industry: -

- Delay in site mobilization.
- Ineffective project planning and scheduling
- Poor project management and inadequate manpower.
- Partial authority of Project Manager.
- Equipment breakdown and maintenance problems
- Less-experienced & incompetent manpower engaged.
- Shortage of resources (Manpower and Machinery).
- Poor site management and supervision.
- Contractor's financial difficulties.
- Delay in staff (Permanent/Contract) salary, Daily wedges labor payment.
- Delay in Vendor (Sub-contractor, Supplier and design consultant) Payment.
- Frequently leaving the project by contractor's staff including top management.
- Less-experienced & incompetent design consultant (including Survey & Geotech work) engaged for design the highway/expressway.
- Inadequate supply of materials.
- Faulty selection of the vendors.
- Untimely performance by suppliers.
- Late performance of subcontractors.
- Faulty workmanship by the contractor and subcontractors.
- Poor communication and coordination by contractor with Client/ Contractor.
- A project specific labor strike caused by either the contractor's unwillingness to meet with labor representatives or by unfair labor practices.
- Conflicts in sub-contractor's schedule in execution of project
- Rework due to errors during construction.
- Site accidents due to lack of safety measures. Corruption has a serious impact on construction delay.

4.4-External Related Delay Factors: -

Several studies have identified external related delay factors category as one of the groups of causes of schedule delays in construction projects.

- Price escalation.
- Inclement weather
- Labor disputes and strikes
- Government regulations.
- Slow permit by government
- Civil disturbances and acts of God consecutively were critical
- Major Cause of delay in obtaining work permits from authorities
- Effects and different of subsurface conditions (e.g. soil, high water table, etc.)
- Extreme weather effect on construction activities
- Unavailability of utilities in site (such as, water, electricity, telephone, etc.
- Effect of social and cultural factors,
- Traffic control and restriction at job site
- Accident during construction
- Changes in government regulations and laws
- Delay in performing final inspection and certification by a third party
- Shortage of construction materials in market
- Delay in manufacturing special highway construction materials
- Dependency on imported materials
- Global financial crisis and unexpected surface and subsurface conditions
- Problems with neighbors and unforeseen site conditions

5. Impacts of Construction Delays: -

The effect of construction delays carries a rippling effect on the contracting parties and the citizens in an economy. Unlike the causes that may have some geographical restrictions, the impact is universal in nature.

- Time overruns.
- The contractor's profit has been greatly reduced due to cost overruns.
- Non-productivity losses of the owners due to long-term stay during the construction phase.
- Do not trust the contractor damaging the reputation of the company.
- Do not trust the owner to delay the payment that led to the contractor's cash flow.
- Project participants are in dispute, arbitration or litigation.
- Exit the project.
- It is difficult to improve the market value of the contractor's business.
- To the consultants, it remains a dent in their reputation as clients lose confidence in their execution plan.
- Delays in construction projects can lead to the parties abandoning the project entirely.
- If a construction project gets abandoned, it reduces employment opportunities, slows down economic activities, government loses revenue and foreign investors get deterred from funding construction projects in the economy.

- there is a serious damage to the reputation of the parties to the construction contract.

6. CONCLUSIONS

The first step in reducing the delays in highway construction project is to understand the root causes of the delay. The results provide a listing of root causes and issues that are directly responsible for most infrastructure construction project delays. Additionally, it is found that fundamental principles must be adopted before significant improvements can be made.

This study reviews the factors that cause delay in the construction industry particularly for highway/Expressway projects in India. Thus, it involved about various factors consisting of various construction phases. Based on this review, the top most common and frequently occurred factor that cause delay in the construction projects particularly for highway projects is the various reasons which is mentioned in previous chapters. Therefore, this review is of utmost important in construction industry especially in highway and road construction projects.

The top five severe causes of delay as seen from the combined view of contractors and consultants are the following: -

- Political situation.
- Award project to lowest bid price.
- Unable to Handover the required & Hindrance free Right of Way (ROW) on time by Client.
- Progress payments delayed by owner.
- Insufficient & incompetent manpower engaged.

This study reviews the factors that cause delay in the construction industry particularly for road and highway projects worldwide. Thus, it involved about 92 factors consisting of various construction phases. Based on this review, the top most common and frequently occurred factor that cause delay in the construction projects particularly for road and highway projects is the poor project planning and scheduling. The frequency of occurrences of the factor in the construction projects and the percentage value was 25 times and 2.5% respectively. Therefore, this review is of utmost important in construction industry especially in highway and road construction projects.

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