

Study of Delay in Execution of Infrastructure Projects – Highway Construction

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Abstract- Nowadays, highway construction suffers from delay and cost overruns, which causes traffic problems, changes of design, poor planning, disputes, cost overruns, poor safety practices and time delays. Researchers in developed countries have realized the seriousness of this shortfall and suggested solutions to resolve it. Due to the inherent risks and increasing complexity of modern construction projects, delays and cost overruns have become common facts in the industry. Researchers and practitioners have used many techniques to assess project delays and apportion delay responsibility among the parties involved. This research deals with the causes which severely effect in delay of infrastructure projects in India. The delays and cost overruns have become a hallmark of infrastructure projects in India, research in delay and cost overrun in highway projects has not been popular researched yet. Any construction project success can be realized by achieving its objectives within the planned time, budget and level of quality. One of the major problems that face the construction projects in general and road projects in specific is being behind the schedule, i.e., delay in submission. Delay can be defined as postponing the project completion time due to predicted and unpredicted causes. Completion time is very essential in construction; because “Time is Money”. In some cases, to the contractor, delay causes higher overhead costs because of longer construction period. As well as that, material costs may increase due to inflation. To the client, especially if he is investor, delay means losing profits that are planned to be earned after starting the investment on the scheduled time.

Index Terms- Cost overruns; Time overruns; Causes of Delay; Frequency Index; Severity Index; Importance Index.

I. INTRODUCTION

A commonality among state departments of transportation is the inability to complete transportation projects on time and within budget. Time delay, cost overruns are generally due to factors such as design errors, unexpected site conditions, increases in project scope, weather conditions, and other project changes. A cost overrun may be generally expressed as a percent difference between the final cost of the project and the contract award amount. When this value is negative, it is called a cost under run. A time delay is simply the difference between a project’s original contract period at the time of bidding and its overall actual contract period at the end of construction. Indian infrastructure investment in general and highway construction in particular have seen manifold increase in the recent times. This

has brought about a paradigm shift in the way in which the highway construction industry has been conducting its business with increased pressure on its stakeholders, namely the employers, the contractors and the consultants for high quality and timely project delivery. A primary goal of highway agencies is to serve the public by providing timely construction of highways with the least disruption to the public. A significant annoyance to the public is when important projects are not completed in a timely manner and when the actual progress of the construction work is longer than necessary, thereby prolonging the inconvenience. The problem of delays in highway construction has been a priority issue for years.

II. LITERATURE REVIEW

In analyzing time and cost overruns of construction projects in India, Iyer and Jha (2006) concluded that two success factors and one failure factor; commitment of project participants, owner’s competence and conflict among project participants contributed significantly in the enhancement of the performance of a project.

Root causes of delays in construction projects were defined as situations and conditions in sufficient detail that violated the fundamental principles to allow corrective action to be taken (Ellis and Randolph 2003). A listing of most common root causes categorized under seven major categories such as business practices, procedures, utilities, site conditions, planning and scheduling, traffic management and design errors has been provided. Although the survey for root cause of delay from both state highway agencies and constructors were listed separately, it was found that most of them were common for both sides.

Arun and Rao (2007) dealt with an innovative Decision Support Tool that could predict the duration overrun, cost overrun and activities associated with any specific delay in highway construction projects. Simulation models for duration and cost overrun of the project was developed based on the nature of delay, activities associated with the delay and classified as controllable and uncontrollable factors. Based on the opinion of senior project implementers from sixty four consultants and professionals in highway construction sector of India, the main risk factors were categorized in this work.

The actual problems connected with highway projects of large size with illustrations from one of the packages of the Golden Quadrilateral project spanning between Delhi and Kolkata, India was reported (Sharma 2004).

III. RESERACH METHODOLOGY

The research through literature reviews and discussion with some parties involved in the construction industry identified a total of 53 causes and 11 effects which are mainly affecting in the delay of Highway construction projects. A questionnaire was developed in order to evaluate the frequency of occurrence, severity and importance of the identified causes. Data were gathered through a survey, analysed by using frequency, severity and importance indices, taking in view owners, contractors and consultants. Agreement on the ranking of the importance of the causes of delay between each two groups of parties was also tested. Recommendations for minimizing delay in construction projects were emphasized in view of the results of the study.

Questionnaire Design:

Data were gathered through a questionnaire. The questionnaire is divided into two main parts. Part 1 is related to general information for both the company and respondent. Owners, contractors and consultants were further requested to answer questions pertaining to their experience in the construction industry and their opinions about the percentage average time delay in projects they experienced. Part 2 includes the list of the identified causes of delay in construction project. These causes are classified into nine groups according to the sources of delay: factors related to owner, contractor, consultant, services and utilities, government regulations and external environment.

For each factor or cause two questions were asked: What is the frequency of occurrence for this cause? &

What is the degree of severity of this cause in project delay? Both Frequency of occurrence and severity were categorized as follows: always, often, sometimes and rarely (on 4 to 1 point scale). Similarly, degree of severity was categorized as follows: extreme, great, moderate, and little (on 4 to 1 point scale).

Data Analysis Approach:

The collected data were analyzed through the following statistical techniques and indices:

1. Frequency Index: A formula is used to rank causes of delay based on frequency of occurrence as identified by the participants.
2. Frequency Index = $(\sum (a n) \div N) * (100 \div 4)$ 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 the total number of responses.
3. Severity Index: A formula is used to rank causes of delay based on severity of occurrence as identified by the participants.
4. Severity Index = $(\sum (a n) \div N) * (100 \div 4)$ 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 the total number of responses.
5. Importance Index: The importance index of cause is calculated as a function of both frequency and severity indices, as follows:
6. Importance Index (I.I %) = $(\text{Frequency Index} \% * \text{Severity Index} \%) \div 100$

Questionnaire Format:

Questionnaire Form For Delay Analysis In Infrastructure Projects

This Questionnaire focuses on the study of causes of delay highway construction Projects. This questionnaire consists of 53 causes of delay and 11 effects on which a detailed analysis will be carried out by using statistical concept. These causes are classified into six groups according to the sources of delay: Factors related to owner, contractor, consultant, services and utilities, government regulations and external environment.

PART I

Please respond to the following details to be filled either by writing your answer in the space provided.

Please note:-

The answers should be based on your experience in construction projects.

All information provided will be treated in the strictest of confidence.

Questions related to the respondent's experience.

1.1. What is your type of business?

- Contractor
- Owner
- Consultant
- Client/ Client representative
- Other please specify _____

1.2. What are the organization being involved?

- Public
- Private
- Both

1.3. How long have you been involved in the infrastructure construction projects?

- <5 years
- 6-10 years
- 11-15 years
- >16 years

1.4. What is the value of the current project you are involved? (You might select more than one)

- Very large
- Large
- Medium
- Small

PART II

Questions related to the performance of project/s you have been involved in.

2.1. How many Highway projects have you participated in?

Please specify _____

2.2. Was one or more of them delayed?

- Yes
- No

If the answer to question 2.2 is NO please go to question 2.6

2.3. How many of them were delayed?

Please specify _____

2.4. What is the average delay time of the delayed project/s?

- Less than 10%
- 10 to 30 %
- 31 to 50 %
- 51 to 100%

Over 100 % please specify _____

2.5. What is the average of delayed time that was authorized by client/s?

- All the delayed time
- About 75% of delayed time
- About 50 % of delayed time
- About 25% of delayed time
- The contractor paid the liquidated damages⁹ for all delayed time.

2.6 Who is the first responsible party for the delay?

- Contractor
- Consultant
- Client

2.7 According to your opinion rate the effect of delay.

(4- Always, 3-Mostly, 2-Sometimes, 1-Seldom, 0-Never)

Table 1. Effects of delay

Sr.No.	Effect	Never	Seldom	Sometimes	Mostly	Always
1	Time overrun					
2	Cost overrun					
3	Litigation					
4	Dispute					
5	Arbitration					
6	Total abandonment					
7	Disruption of traffic movement					
8	Delay of other projects related to the main one					
9	Obstruction of economical and urban development					
10	Discredit the Ministry of Works among the people and in the press					
11	Breach of contract					

PART III

For each factor or cause two questions were asked: What is the frequency of occurrence for this cause? & what is the degree of severity of this cause in project delay? Both frequency of occurrence and severity were categorized as follows: always, often, sometimes and rarely (on 4 to 1 point scale). Similarly,

degree of severity was categorized as follows: extreme, great, moderate, and little (on 4 to 1 point scale). Respondents are required to fill the respective places with only scale points (1, 2, 3, and 4) of their opinion.

Table 2. Frequency of Occurrence

Scale Points	Category	Explanation
1	Rarely	Occurs only 1 time out of 10 projects (>10%).
2	Sometimes	Occurs in 1 to 5 projects out of 10 projects (10%-50%).
3	Often	Occurs in 5 to 7 projects out of 10 projects (50%-70%).
4	Always	Generally occurs in all the projects (70%-100%).

Table 3. Degree of Severity

Scale Points	Category	Explanation
1	Little	Less than 10% increase in cost and time of project.
2	Moderate	10% to 25% increase in cost and time of project.
3	Great	25% to 50% increase in cost and time of project.
4	Extreme	Greater than 50% increase in cost and time

The Six Categories of Delay are:

1. Causes related to Contractor
2. Causes related to Owner
3. Cases related to Consultant
4. Cases related to Services and Utilities
5. Causes related to Government Regulations

Table 4.Importance and ranking of contractor related delay causes

Cause no.	causes of delay	F.I %	S.I%	I.I%	Overall Rank
7	Ineffective construction method implemented by contractor	47.91667	75	35.9375	21
9	Shortage of materials	47.91667	75	35.9375	22
10	Payment problems between contractor and his employees	50	62.5	31.25	27
5	Improper planning and scheduling of project by contractor	43.75	70.83333	30.98958	28
2	Rework due to errors during execution	37.5	75	28.125	32
4	Poor communication between contractor and other project parties	43.75	58.33333	25.52083	34
6	Inexperienced contractor's manpower	41.66667	56.25	23.4375	39
8	Shortage of manpower	31.25	66.66667	20.83333	44
1	Difficulties in project financing by contractor	43.75	45.83333	20.05208	45
3	Poor site management and supervision by contractor	32.69231	50	16.34615	50
11	Shortage of equipment	20.83333	75	15.625	53

Table 5.Importance and ranking of owner related delay causes

Cause No.	Causes Of Delay	F.I %	S.I %	I.I %	Overall Rank
14	Interference by the owner during execution operation	64.58333	60.41667	39.0191	17
13	Delay in decision making by the owner	58.33333	62.5	36.45833	19
15	Delay in progress payments by owner	64.58333	56.25	36.32813	20
12	Budget availability for the project	52.08333	64.58333	33.63715	24
16	Lateness in reviewing and approving contract documents by the owner	54.16667	56.25	30.46875	29

17	Delay in approving shop drawings and sample materials	50	56.25	28.125	31
20	Poor communication between owner and other project parties	41.66667	62.5	26.04167	34
19	Suspension of work by owner	35.41667	70.83333	25.08681	37
18	Change of project scope	31.25	72.91667	22.78646	40

Table 6.Importance and ranking of consultant related delay causes

Cause No.	Causes Of Delay	F.I%	S.I%	I.I%	Overall Rank
31	Delay in solving design problems	41.66667	72.91667	30.38194	30
32	Major change of design during construction by consultant	35.41667	77.08333	27.30035	33
27	Bad project cost estimation	31.25	81.25	25.39063	36
28	Missing dimensions in the drawings	31.25	79.16667	24.73958	38
26	Discrepancies between specifications and drawings prepared by consultant	32.69231	68.75	22.47596	41
29	Lack of competent person to monitor the progress at site	35.41667	62.5	22.13542	42
22	Delay in approving major changes in the scope of work by consultant	31.25	62.5	19.53125	46
30	Delay in issuing the drawings	35.41667	54.16667	19.18403	47
25	Insufficient experience by consultant	31.25	56.25	17.57813	48
24	Delay in reviewing and approving design documents by consultant	33.33333	52.08333	17.36111	49
23	Poor communication between consultant and other project parties	35.41667	45.83333	16.23264	51
21	Delay in performing testing and inspection by consultant	33.33333	47.91667	15.97222	52

Table 7.Importance and ranking of services and utilities related delay causes

Cause No.	Causes Of Delay	F.I%	S.I%	I.I%	Overall Rank
33	Utilities are unidentified or incorrectly located	81.25	81.25	66.01563	2
38	The standard of practice for designers with regard to communicating utility information on drawings is not clearly defined	79.16667	77.08333	61.02431	4
37	Utility location information provided on drawings is not clear particularly for complex intersections	77.08333	79.16667	61.02431	5
34	Many smaller utilities have no as-built drawings	72.91667	79.16667	57.72569	7
41	Delays in the relocation of utilities	77.08333	72.91667	56.2066	8
42	Utilities may not see work as a priority	75	72.91667	54.6875	9
35	Often, the as-built drawings are incorrect	72.91667	72.91667	53.1684	10
39	Slow response by utilities to improve their processes	70.83333	70.83333	50.17361	12
36	As-built location information may not	68.75	72.91667	50.13021	13

	include vertical location				
40	Smaller utilities are restrained by funding limitation	66.66667	72.91667	48.61111	16

Table 8.Importance and ranking of Government regulations related delay causes

Cause No.	Causes Of Delay	F.I%	S.I%	I.I%	Overall Rank
43	Difficulties in obtaining work permits	87.5	87.5	76.5625	1
44	Tendering system requirement of selecting the lowest bidder	70.83333	70.83333	50.17361	11
47	Land acquisition	62.5	79.16667	49.47917	14
46	Change in government regulations and rule	37.5	83.33333	31.25	26
45	Summer restriction on time of work	29.16667	72.91667	21.26736	43

Table 9.Importance and ranking of External Environment related delay causes

Cause No.	Causes Of Delay	F.I%	S.I%	I.I%	Overall Rank
49	Traffic diversion	79.16667	79.16667	62.67361	3
48	Hot weather effect on execution activities	79.16667	77.08333	61.02431	6
53	Scarcity of materials in the market	54.16667	75	40.625	16
51	Accidents at execution site	54.16667	70.83333	38.36806	18
50	Effect of social and cultural conditions of inhabitants	62.5	56.25	35.15625	23
52	Political situation and security	45.83333	70.83333	32.46528	25

Extremely Severe	
Very Severe	
Severe	

IV. DISCUSSIONS AND RESULTS

This section discusses the results obtained in the previous section. First, we discuss the severest and most frequent causes of delay within each group. Second, we discuss the most frequent effects of delay

Causes related to owner

- Interference in work by owner: interference in work was ranked as the first severest cause related to owner. According to conditions of contract, the owner has the right to suspend any part of work if it is required to restudy or redesign the project to make the necessary modifications . If interference by owner will frequent without reason it may obstruct the work of contractor, and causes delay for the project.
- Delay in decision making: The results indicated that delay in decision making is the second severest cause related to owner. Slowness of owner in making decisions may hold back some of project activities, and

delay in settlement of contractor’s claims by the owner, such as approval of new work items, prices and additional costs for changes in design. This may obstruct the progress of work and subject the project for delay.

- Delay in progress payments by owner: the results shows that progress payment is third severest cause related to owner. This may occur due to unavailable financial resources to other projects. Without providing the budget, the project remains only in papers without execution.

Causes related to contractor

- Ineffective construction method implemented by contractor: this was ranked as the first severest cause related to contractor. Contractors may fail to come out with a practical work program at the initial work stage. This failure is interrelated with lack of effective methods of construction and insufficient contractor’s experience towards the projects. Improper planning at

the initial stages of a project causes delays at various stages.

- Shortage of materials: The contractor obligates himself to provide the required equipment and materials to execute the project within the time schedule. Shortage or unavailability of the required equipment and materials may obstruct the progress of work and may subject the project for delay.
- Payment problems between contractor and his employees: Some contractors encountered reduction in their financial resources due to the "Credit Crunch", the global financial crisis. Cash requirement for procurement of materials and other expenses could lead the contractor into a very critical situation which may obstruct the progress of work and postpone the project completion time.

Causes related to consultant

- Results showed that there are three severe causes related to consultant, these are: Delay in solving design problems, Major change of design during construction by consultant, Bad project cost estimation. It can be observed that these causes are related to insufficient experience of the consultant's staff. When consultant makes fundamental changes in design, the contractor may face difficulties in construction or in finance because these changes weren't planned. Moreover, when projects' costs are under-estimated, it may be suspended by the owner due to his inability to finance additional costs. Additionally, delay in approvals by consultant could delay the progress of work and may cause delay in completion time of the project.

Causes related to services and utilities

- All causes related to services and utilities were ranked as frequent and severe, which indicates the importance of this group. Utilities are unidentified or incorrectly located is ranked as the first most frequent and severest cause in this group. This may result from unavailability of designs and exact location maps. Unclear or undefined positions of services networks in drawings can subject the project to delay; because the schedule will be changed and the newly discovered pipe or cable is required to be moved or diverted temporarily which requires additional time and money.

Causes related to Government regulations

- Difficulties in obtaining work permits: Among the severest problems related to Government regulations which affect the progress of public road projects is the issuance of work permits. The contractor must obtain work permits from all concerned Government authorities. Each of these authorities has its own regulations and rules in issuing work permits. Contractor may face difficulties in obtaining these permits causing delay for the project.
- Tendering system requirement of selecting the lowest bidder: It is important to reconsider the governmental strategies that encourage the selection of the lowest bidding contractors and to improve the routine procedures and requirements that are required for obtaining work permits.

- Land acquisition: Land acquisition is a sensitive issue so humane, systematic and transparent approach need to be adopted for early and peaceful acquisition. Land acquisition must take place in a manner that fully protects the interests of land-owners and also of those whose livelihoods depend on the land being acquired. So an adequate compensation package which shall included reasonable compensation for land and resettlement and rehabilitation measures to assuage the sufferings of the affected persons and projects.

Causes related to external environment

- Traffic diversion: Traffic diversion is found to be the first severest and most frequent cause related to external environment. Improving the performance of an intersection by constructing a flyover and / or subway involves working at already used highway. If this highway is linking between important regions in the country, it is difficult to close it until the construction finishes. Congestions in this highway are required to be diverted for temporary ways and this may obstruct the progress of work and causes delay for the project.
- Hot weather effect on construction activities: The climate in Bahrain is very hot, where the temperature may exceed 49 °C in summer which makes the construction very difficult. The weather may affect the productivity of labours and equipment, which may delay the progress of work.
- Scarcity of materials in the market: The factor "scarcity of materials in the market" was Ranked third. Construction projects are physical projects, and the timely availability of Materials is very important.

Delay effects

Results indicated that the four most frequent effects of delay are:

- . Cost overrun
- Time overrun
- Disruption of traffic movement
- Dispute

When the project is subjected to delay, it will exceed the specified period which means waste of time that may be used in other profit making projects. As well as that, delay causes cost overrun because time is money. The contractor will pay more for overhead, labours and machinery. On the other hand, owner's money will be tied up with this delayed project. Moreover, closing main roads for development and construction will disrupt traffic movement. Additionally, roads provide links that connect the road users to other areas that may include recreational and investment projects. So delay in road projects may lead to delay in these investment projects that depend on them.

V. CONCLUSION AND RECOMMENDATIONS

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. The data were collected from the following respondents....

Landmark Corporation Pvt Ltd Mumbai, Construct Infotech Mumbai, Patils Constructions Sangli, P.S.C Infracon Pvt Ltd Dattawadi, M/S Anant Associates Pune, Fabstruc Signs Pvt Ltd Mumbai, Destech Pvt Ltd Mumbai, J Kumars Construction Pvt Ltd Mumbai Etc.

This work discussed the delay in road projects in Bahrain. It studied the frequency and severity of delay causes, as well as the frequency of delay effects. The research is a field survey through a questionnaire directed to contractors, consultants, and owner who is the Ministry of Works. It was concluded that there are many causes of delay related to contractors such as Ineffective construction method implementation, Shortage of materials

Payment problems between contractor and his employees . The major causes related to the owner, i.e. MOW, are Interference by the owner during execution operation, Delay in decision making by the owner, Delay in progress payments by owner. The main problems related to consultants are due to lack of experience. Delay causes related to services and utilities are the most critical factors as indicated by the high values of their severity means. Moreover, cost and time overruns and disruption of traffic movement were the most frequent effects of delay.

Recommendations for future studies

It is recommended to further this research by investigating actual delay case studies in India. Furthermore the associated cost of delay in highway projects should be studied and analysed.

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