Developing a framework for mitigation of project delays in roads and highways sector projects in India

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Abstract
Roads and highway sector 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 road construction sector, it is very important to systematically analyze the factors of delays and to build up a concise understanding amongst the roads and highways professionals. Adopting a comprehensive project stakeholders analysis namely client, consultant and contractor, the research identified the important factors affecting the delays in Indian roads and highway 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 road 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 road construction industry, and accordingly proposes a suggestive framework to design a construction project in an efficient manner and assisting mitigating of delays.

Keywords: Project delays, Framework analysis, Factor analysis, Conceptual framework.

Research Objective

To develop a framework to mitigate the project delays by analyzing the impact of these identified critical factors causing project delays in Roads and highway sector in India.

Research Design

Using the analysis of results obtained from factor analysis and coding, a suggestive framework was developed to mitigate the road construction projects delays in India. Numerous suggestions which were proposed by the domain professionals were included in the process of construction of framework. Personal interview and face to face discussion techniques were utilized to authenticate and validate the proposed suggestive framework.[5]

The analysis of the data was carried out using qualitative analysis software Atlas.ti. The software helped in coding, creating memos, searching, linking codes and text segments, revising and reorganizing. It facilitate visual display of data and findings (Creswell, 2007)

The research process has been explained in the flow diagram as below:

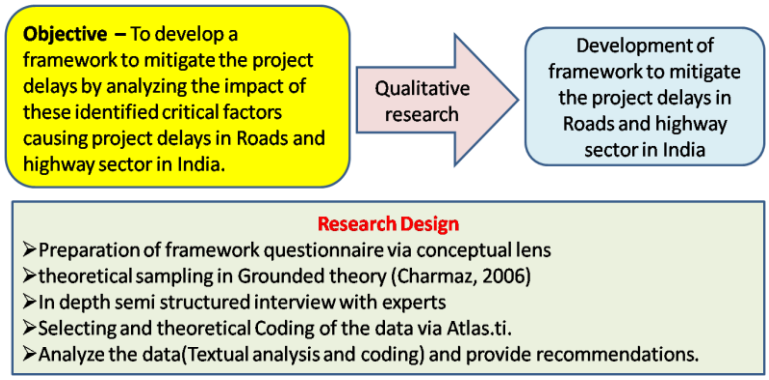

Fig. 1: Research methodology

The conceptual framework helps connecting the researcher with the existing knowledge. Guided by an appropriate theory, researchers have a foundation for their hypotheses and selection of research methods.

A suitable conceptual framework to be developed after identifying the factors causing project delays and

assessment of impact of these identified critical factors. Suitable measures for mitigation of project delays will be developed once the severity analysis and assessment of each of these factors on project delays is done.[8]

Exploratory Factor Analysis (EFA)

Factor analysis is a technique for data reduction. Exploratory Factor Analysis is utilized in situations where associations between the latent variables and observed variables are uncertain or unknown. Hence after compilation of the questionnaire, an EFA will be done to establish the extent to which the variables measured are connected to the latent constructs.[9]

As the factors (sub constructs) influencing the delays in project implementation were not classified prior in any of the literature review, an exploratory factor analysis was first conducted for the pilot data to check whether all items are loaded to one only component or whether the items are loaded into different components or factors.

The factor analysis conducted here, the Principle Component Analysis (PCA) technique is used. Sampling adequacy has to be checked before applying the PCA method using the Kaiser Meyer Olkin (KMO) and Bartlett's test; the values obtained after analysis, were 0.632 for client, 0.787 for consultant and 0.685 for contractor respectively. This depicts that the variables are co related and dependent on each other, which is an essential condition to carry out the factor analysis. Therefore PCA technique using factor analysis can be applied. Using PCA technique, Eigen values are determined to establish the factors.

Table 1: Sampling adequacy test (The sampling adequacy greater than 0.90 is excellent, while below 0.50 is unacceptable), Source: SPSS V20.0 software analysis

KMO and Bartlett's Test		Client	Consultant	Contractor
Kaiser Meyer Olkin Measure of Sampling Adequacy.		0.632	0.787	0.685
	Approx. Chi-Square	974.96	1066.39	1372.337
Bartlett's Test of Sphericity	df	630	780	861
	Sig.	0	0	0

Using PCA method as shown in table no 2, 5 factors were identified for contractors whose total variance cumulative percentage is explained by 70.332%. This implies that the 70.332% of variance is explained by the 5 factors. Accordingly, a total 26 of Items have been classified into five factors through Principal Component Analysis (PCA) technique and labeling of each factor is done appropriately based on the factors loadings. Refer table 3.

Table 2: EFA Result: rotated component matrix for clients (Rotated component matrix)

	Component				
	1	**2**	**3**	**4**	**5**
Q14	.624				
Q12	.556				
Q27	.502		-.383		
Q11	.482	.430			
Q32	.475				
Q30	.431				.387
Q33	.404				
Q29	-.356				
Q15	.312				
Q25		.592			
Q36		-.584		.326	
Q28	-.324	.500		.308	
Q24		-.475			-.344
Q13		.364			
Q31			.602	-.330	
Q8			.579		
Q10			.576		
Q9			-.397		
Q3				-.655	
Q1	-.392			.536	
Q4				.422	
Q5				-.328	

Q18		.411			-.539
Q34					.451
Q2					-.434
Q17					.328

Extraction Method: Principal component analysis

Table 3: Classification of items (variables) of delay factors as perceived by the clients

Item	Factor Label
Force majeure activities/unforeseen circumstances Project complexity (Project type, project scale,etc) Improper conflict resolution process adopted Improper project feasibility study Frequent project scope/Design changes Improper contractor/Consultant selection Slow decision making process Ambiguous project requirements Unrealistic contract/project duration	Contract related Delays (F1)
Poor site access Lack of client representatives at site Severe weather conditions at site Geological problems on site Change/Transfer of project personnel during project execution	Site related Delays (F2)
Delay in progress payments Price fluctuations due to Inflation Lack of project funding Global/National Economic crises	Financial related delays (F3)
Change in government policies affecting project Law and order situation/Security threats/Local Agitations Delay in Center/State government document clearance process/ bureaucratic delays Change in political power at State/ Center	Political related delays (F4)
Issues in client procured materials Lack of competent/expert project domain people Land acquisition problems Delay in selection of PMC/contractors/suppliers	Resource related delays (F5)

Using PCA method from table no 4, 4 factors were identified for contractors whose total variance cumulative percentage is explained by 64.318%. This implies that the 64.318% of variance is explained by the 4 factors. Accordingly, a total 28 of items has been classified into four factors through Principal Component Analysis (PCA) technique and labeling of each factor is done appropriately based on the factors loadings. Refer table 5.

Table 4: EFA Result: Rotated component matrix for consultants

		Component		
	1	**2**	**3**	**4**
Q39	.737			
Q12	.718			
Q22	.682	-.426		
Q38	.643			
Q13	.641			
Q23	.637			-.350
Q28	.629			
Q40	.592		-.423	
Q19	.587			
Q20	.574			
Q11	.564	.322		
Q21	.561			

Q6	.524	.845		
Q5		.828		-.394
Q4		.692	.144	
Q16		.579		
Q31				
Q35			.834	.432
Q34			.699	
Q37	.361		.636	
Q26		.280	.630	
Q33			.522	
Q2				.754
Q1				.702
Q8		-.442		.604
Q18	.386			.573
Q9				.556
Q3			-.320	.535

Extraction Method: Principal component analysis.
Rotation Method: Varimax with Kaiser
Narmaliation.

a. Rotation converged in 9 iterations.

Table 5: Classification of items (variables) of delay factors as perceived by the Consultants

Item	Factor Label
Delay in site inspection and handover Improper project monitoring and tracking site progress Poor site management, supervision & control Rework due to frequent revisions in drawings Lack of responsibility/accountability for site related issues Delay in issue of work permits to contractor Rework due to design errors in drawings Low constructability or an Impractical designs Change in scope of work/Additional work Delay in provisions of utilities at site (water, electricity,etc) Ignoring safety compliances/PPE at site leading to accidents Delay in approvals of drawings/documents Incompetence to contractor's technical queries	Delays due to design and site related issues (F6
Delay in quality check inspections/approvals of materials at site Delay in RA bill certifications leading to contractors fund shortage Staff shortage due to holidays/staff leaves/absenteeism Lack of monitoring of availability of equipment at site	Delays due to Resource management issues(F7)
Lack of consultation with client/contractor Unclear lines of responsibility Delay in issue of EOT/Approvals to contractor Lack of participating in site meetings Poor project planning/project tracking by consultant	Delays due to communication related issues (F8)
Non compliance to contract clauses/conditions Change in material type/specifications after BOQ finalization Improper project feasibility/technical study Delay in rate finalization for extra items Inaccurate project cost/budget estimation Improper settlement of contractors claims leading to arbitration	Delays due to contract management issues (F9)

Using PCA method from table no 6, 4 factors were identified for contractors whose total variance cumulative percentage is explained by 67.161%. This implies that the 67.161% of variance is explained by the 4 factors. Accordingly, a total 28 of items has been classified into four factors through Principal Component Analysis (PCA) technique and labeling of each factor is done appropriately based on the factors loadings. Refer table 7

Table 6: EFA Result: Rotated component matrix for contractors

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
Q33	.730				
Q37	-.695				
Q26	.675			-.312	
Q27	.615				
Q34	.608		-.385		
Q40	.559				
Q23	.547				
Q15		.758			
Q28		.733			
Q14		.674			.329
Q20		.666			
Q19	-.411	.581			
Q13		-.535	-.315		
Q12		.518			
Q38		.506			
Q5			.816		
Q4			.803	-.512	
Q16			.727		
Q31		-.473	.538		
Q2			.403	.742	
Q1				.739	
Q18				.665	
Q10				.599	
Q17				.538	
Q39		.422			.776
Q6					-.667
Q11			.421		.557
Q30					.532

Extraction Method: Principal Component Analysis.

Table 7: Classification of items (variables) of delay factors as perceived by the contractors

Item	Factor Label
Inappropriate construction methods used Rework due to errors during execution Improper Geological study Poor site supervision and control Frequent Equipment Breakdowns Accidents during construction/Safety not followed Low labor productivity	Delays due to execution related issues (F10)
Improper selection/Change of sub-contractors Unrealistic project schedule bided by the contractor team Delay in request for approvals of Documents/drawings Poor site mobilization Failure to utilize Project management tools (MSP, P6, EVM, etc) Delay in work permits to sub contractors/Labours Delay in provision of utilities at site (Water, electricity, etc) Poor manpower planning/lack of expertise	Delay due to Planning Deficiency (F11)
Lack of/poor communication with client/consultant Lack of timely decision and corrective actions by the contractor team Bitter relationship with consultant/Client Unclear lines of responsibility/authority	Delays due to communication related issues (F12)
Conflict on ambiguous contract clauses framed Poor project technical feasibility study during bidding stage Improper project design/constructability Disagreement on design/specifications with consultants	Delays due to contract related issues (F13)

Delay in submission of RA bills	
Labor absenteeism at site Lack of equipment availability Material shortage at site/Quality issues Unavailability of Qualified staff	Delays due to lack of resources (F14)

Data Collection Method

A special feature of Grounded theory is the simultaneous collection and analysis of data (Glaser & Staruss, 1967). This indicates an iterative process with constant comparison between data collection based on theoretical sampling, rather than a linear process where data analysis begins when data collection is complete. However for the purpose of proving clarity to the readers, this abstract follows a positivist paradigm and present literature upfront followed by methods and then findings.[10]

Corbin & Strauss (2008) opine that most data dense interviews are those that are unstructured, therefore unstructured interviews were conducted to collect data from the participants. If a researcher enters the field with a structured questionnaire, participants will answer only that which is asked, and often without elaboration. The participants might have other information to offer, which they don't share fearing that they might disturb the research process (Corbin and Morse, 2003).[11]

The interview Protocol was used to guide the process on interview; it included the interview style, procedure ad general rules to be followed. As per Patton (1990), the interview styles for this research are based on qualitative interview techniques which employ a flexible outline of questions and various topics. Though a few initial questions are asked, the phrasing of the question is not preset & the focus of the enquiry gets progressed with the interviews (Patton, 1990).[12]

Atlias. Ti Coding

Coding, an essential element to the formation of grounded theory, which extracts concepts from preliminary and raw data and develops them to define their properties and dimensions (Corbin & Strauss 2008). Coding is to categorize various segments of data with a short label that simultaneously will summarize and account for each section of data (Charmaz, 2006).[13]

Fig. 2 depict application of all the above concepts in forming initial codes. Figure 3: depicts Semantic layout output from Atlas.Ti. Fig. 4: Theoretical coding output from Atlas.Ti.

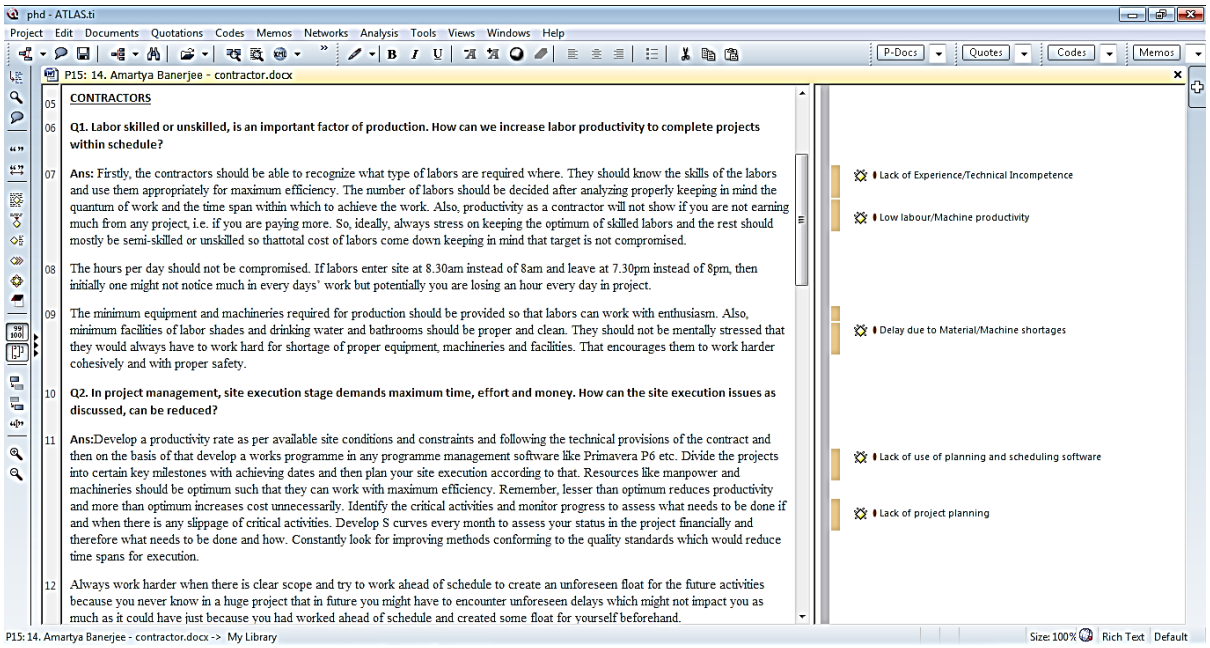

Fig. 1: The snapshot of coding of personal interviews

The transcribed coding provided certain keywords and parameters which were instrumental in the formulation of conceptual framework. These keywords and parameters were utilized in the development of conceptual framework. The output of Atlas TI is as below:-[14]

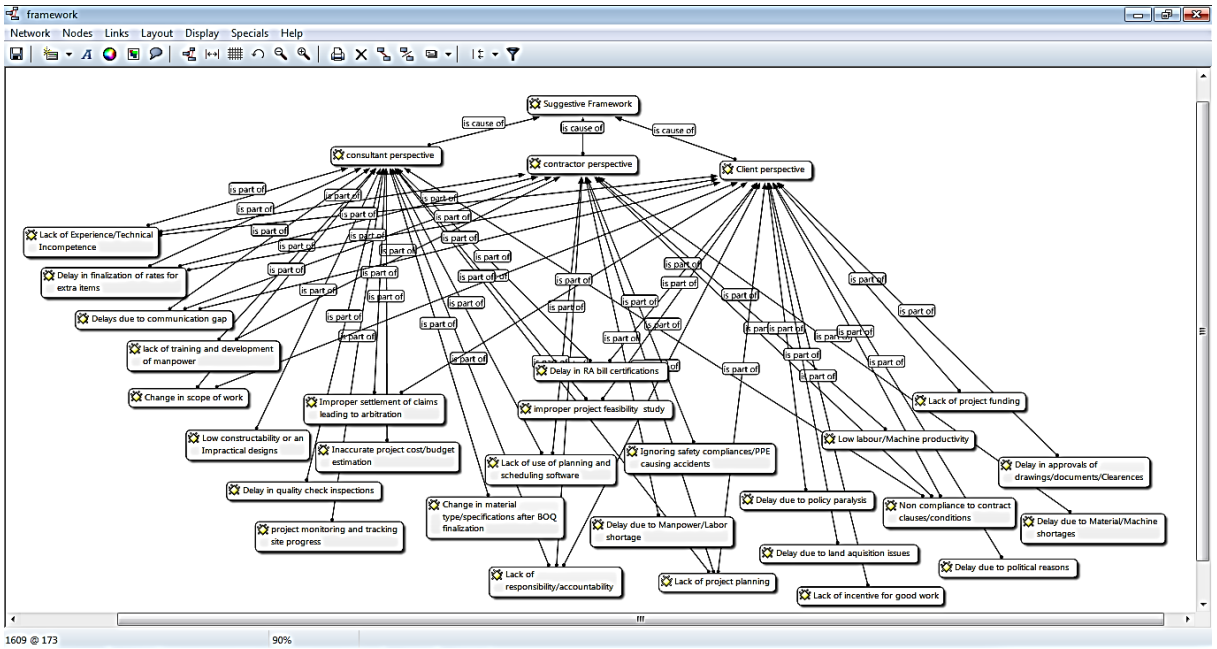

Fig. 2: Semantic layout output from Atlas

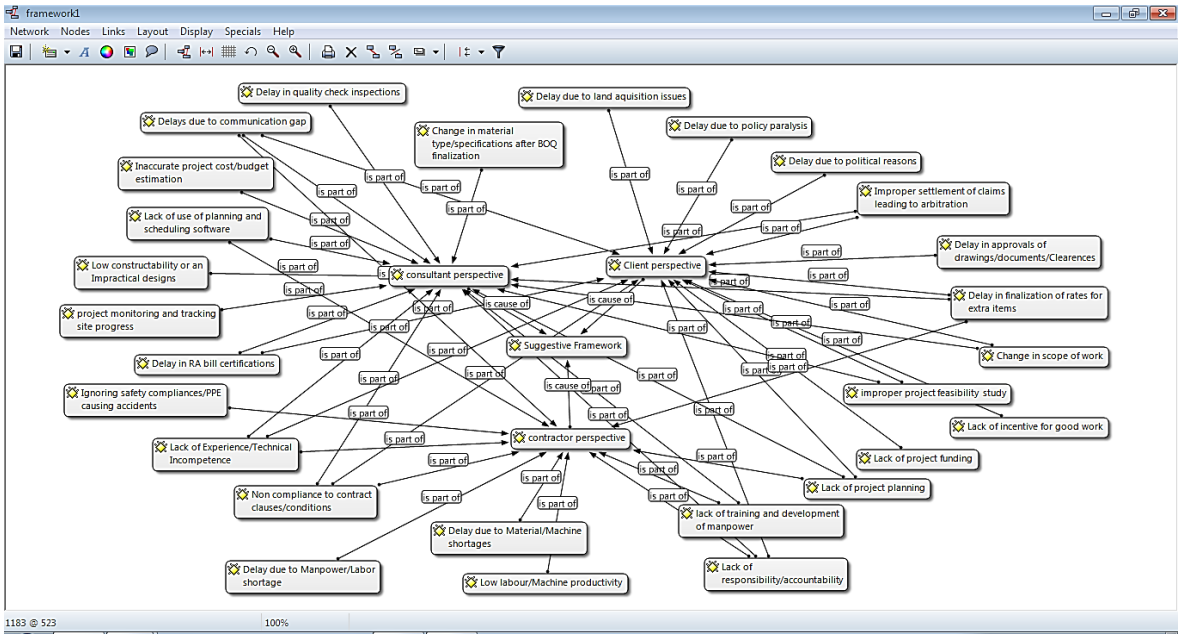

Fig. 4: Theoretical coding output from Atlas.Ti

4. Suggestive framework

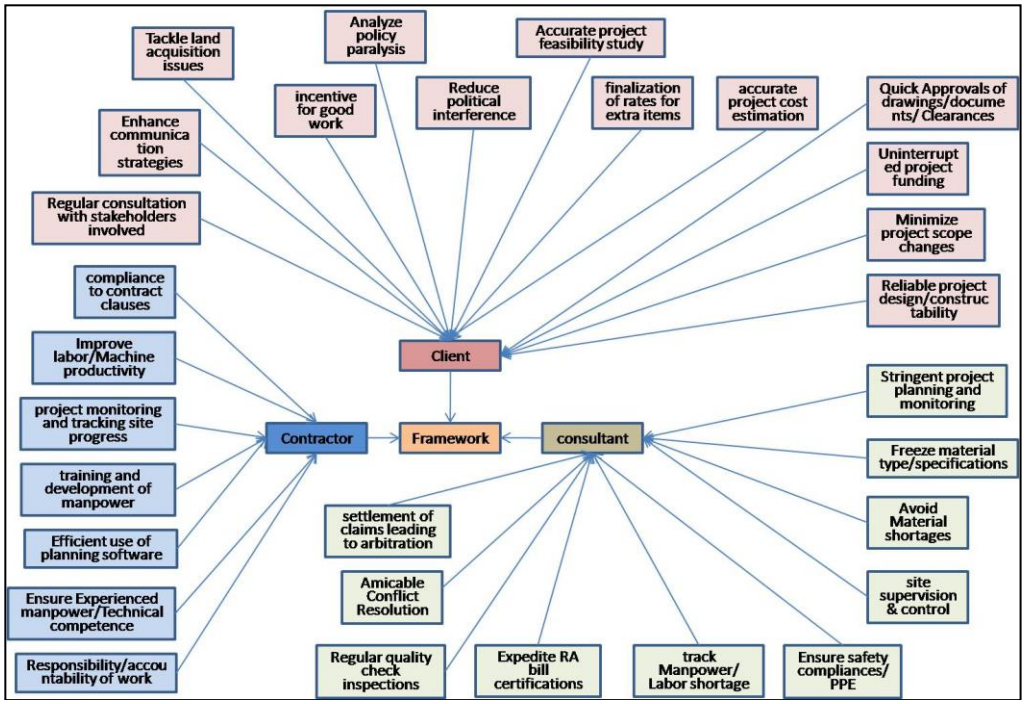

Fig. 5: Suggestive framework for mitigation of project delays

The proposed suggestive framework of the research will pave new inroads in road construction sector and act as guidance for stakeholders effectively addressing the challenges that they will face during execution of road construction project in India. This framework will facilitate to reduce the delays, handle challenging issues in a timely manner, maintain efficient project monitoring, act as warning method for cost and time overruns, and moreover help project team in monitoring road projects and take appropriate actions whether to upgrade, continue or terminate the project. This framework approach is a very helpful tool in minimizing loss or maximizes profits. It will assist the management process for effectively utilization of resources, and in planning the project's progress and execution. Overall it will ensure effective project budgeting, project quality, and suitable techniques for project implementation, to make sure an efficient project execution process with minimum delays and complete the project within the expected time.[15]

Following will be Major Parameters to be kept in Mind while Implementing Framework: Completing the projects on time has always been a major challenge for Client, consultant and contractors. Project to be completed within schedule are commonly affected by several factors, such as regulatory changes, labor or material shortages, abnormal weather, public opposition, funding, conflicting site conditions, and a countless other factors that are not in control of project stakeholders.

The following guidelines emerging from framework are suggested to overcome these challenges and maintain the projects on track.

Decision Making: Delay in decision making is one of the severe cause related to client and consultants as signified by framework analysis results. Sluggishness in decisions making may retard the progress of project activities, resulting in delay of settlement of contractor's claims like approval of new work materials, extra costs for changes in design, etc. resulting in hindrances in the project progress and will cause delay.

Work Permits: Progress of public road projects can be affected by government regulations in issuing of work permits. The contractor is bound to attain work permits from all concerned Government authorities to satisfy the contractual obligations. These stautory authorities have their own rules and regulations for issuing work permits. Contractor often face great difficulties in obtaining these permits resulting in project delays.

Progress Payments: Delay in progress payments can transpire resulting from unavailability of financial resources for other projects. The project will show only in papers with no execution started as there is no budget allocated. Reduction in the financial resources was encountered by some contractors as a result of the "Credit Crunch" causing Payment problems between contractor and his employees. Necessity for cash needed for purchasing of materials and other items can lead to the contractor into a very serious situation which may hinder the growth of work and adjourn the completion time of project.

Land Acquisition: Land acquisition is viewed as a sensitive subject, therefore systematic, transparent and humane approach has to be adopted for early and peaceful acquisition. The acquisition process should be such that it fully safeguards the interests of land-owners and because their livelihood depends on the land being acquired. Hence satisfactory compensation package must be designed and measures for realistic compensation for land, resettlement and rehabilitation to alleviate the sufferings of the concerned projects and people.

Shortage of Materials: For implementation of the project, it is obligation of contractor to arrange the required equipment and materials within the time constraint. Shortage or deficiency of the crucial equipment and materials may hinder the work progress causing project delays.

Change of Design: It is observed that this cause is connected to insufficient experience of the consultant. When consultant makes the changes in design, the contractor will face problems in construction or in arranging budget since these changes were not initially planned. Furthermore, under estimating the project costs may result in termination of the project by the client due to his incapacity to finance extra costs. As a result, delay in approvals by consultant can cause delay in the progress of work causing delay in project completion time.

Utilities Unavailability: Utilities which are unidentified or wrongly located may result from unavailability of designs and precise location maps. Unclear or unidentified location of services in drawings will result in delays causing change in schedule and the newly discovered cable or pipe is desired to be shifted or diverted provisionally which demands extra time and money.

Frequent Interference in work by Client: According to contract conditions, the client has the authority to suspend any part of work for restudying or redesigning the project, to accommodate the necessary adjustments. If interference by client is very frequent without rationale, it may hinder the contractor work, and causing project delays.

Scope Change: Any changes related to scope of the project during execution, will demand entire initial project plan to be reviewed ex. schedule quantity, reviewed budget and quality of the project. This will demand extra time and resources against the initial baseline. To attain a necessary control over scope change, it is imperative to primarily identify the reality that change is inevitable in project and can be favorable to the success of entire project. Thus it is necessary to integrate a suitable change management plan, to adopt the proactive approaches that will involve the project stakeholders and incorporate their requirements throughout the lifecycle of the project. It is necessary to recognize the key success factor in union with the client and institute KPI in the form of milestone that measures the success for achieving the project scope. Likewise, to evade disagreements, contractor should constantly ask for approval for changes in project scope from sponsor and converse changes in a suitable way. The other alternative is to freeze the scope could initially in contractual agreement so that the contractor will concentrate on the expected deliverable.

Design Errors: Design errors constitute errors in field investigation, plan errors, error in design & specifications, design changes etc. The vital thing to be considered is application of competent tools throughout the project and the involvement of professional skills. To achieve error free design, things to be considered are excellent communication with the whole design team and integrating a design process that is suitably planned, giving sufficient time for corrections, widespread reviews and investigation. Precise site investigations to be carried out ensuring all site conditions are prominent in the design, and applying value management to attain the best cost effective design alternatives.

Detailed Schedule Planning: Design should ideally be advanced to at least the 30% level to develop a meaningful construction schedule, which is not always possible. However, a milestone needs to be established before the design is sufficiently advanced and the client is required to build detailed plan as possible. The project schedule should be constructed based on logical sequencing of work with durations based on production schedule, impacts on operating systems, proper allowance for time and weather constraints, etc. The time and cost spent on preparing a inclusive and sensible schedule evades many problems.

Document Lessons Learned: Project teams often feel blessed and relieved when significant project closeout is realized, but failure to bring the same stringency to closeout as was brought during construction phase. To evade this situation, the contractor should include activities for detailed closeout and continuously update them. Meetings every week should also be conducted to press for completion of work within schedule. Lessons learned from what went wrong should be documented and published that will help team planning the next similar project, to avoid the same mistakes.

Conclusion

The research work undertaken here is concerned about the grave problem of the road construction projects delays in India. These project delays results in numerous repercussions namely degrading the quality of completed roads, cost and time overruns, major disruptions in movement of physical goods, and cancellation/abandonment of few projects. Together this repercussions lead to extra costs, not forgetting the restricted budget offered for road construction projects at national and state level. The exorbitant costs arising from delays in road constructions results in considerable decline in the entire stretch of roads

constructed and repaired yearly or it may lead to substandard quality of construction work.

The suggested framework of this research provides fresh dimensions in project management of road projects and guides the stakeholders to successfully encounter the challenges that they occur during any road construction project execution in India. The relevance of this research framework is to mitigate the delays, handle challenging and problematic matters in a timely way, maintain effective project monitoring, serve as a prior warning system for time and cost overruns, and help project team to take timely decisions and the monitor projects so as to upgrade, continue and/or terminate a project.

This framework a valuable and promising tool in minimizing the losses and maximizing the profits. It will also assist to improve the project management process by efficient utilization of resources. Additionally, it will ensure workforce quality, appropriate methods for project execution and financial budgeting, as all essential planning and monitoring will be systemized for ensuring flawless project implementation with minimum project delays and completing it within the contracted time.

Limitations of the Study

The conclusion presented in this research was supported by in-depth interview of experts from Roads and highways sector in India. The study used qualitative interpretive approach which is normally subjective in nature and having limited generalizability (Klein & Myers, 1999). The output being a substantive conceptual framework, its generalizability is limited to the selected domain. Additionally, considering reality as socially constructed, this study does not argue on objectivity, but claims that the emergent theory is one of many possible explanations of reality constructed considering researchers as active instruments. Due to the sensitivity of the research area under study, the experts interviewed didn't allow record all the interviews. Though, the researcher used techniques of questioning, paraphrasing, checking and working on the data collected, immediately after interview to make certain the data is completely captured and correct.

Similar study can be performed related to mitigation of project delays roads and highways sector in other states of India. Studies can be conducted for specific type of infrastructure projects, such as dam construction projects, bridge construction project, utility projects, etc. A in depth research can be done to investigate the consequences of cash flow troubles on delays in construction projects. Comprehensive studies can be conducted to analyze the involvement of a specific resource or entity influencing time overruns in construction projects.

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