Impact Analysis of Delay Factors in Public Infrastructure Projects

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ABSTRACT

Delays in public infrastructure projects continue to pose a significant challenge in India, adversely affecting project execution, economic growth, and the delivery of public services. This study investigates the critical factors contributing to such delays through a structured questionnaire survey conducted among industry professionals, including project managers, contractors, and engineers involved in infrastructure projects. The collected data were analysed using the Relative Importance Index (RII) method to identify and rank the most significant delay factors influencing project performance. The findings reveal that approval-related issues, particularly delays in statutory approvals and conflicts among multiple agencies, are the most dominant contributors to project delays. Financial constraints, including delayed payments and contractor cash flow problems, also have a substantial impact on project continuity. In addition, communication gaps among stakeholders, lack of coordination between departments, and design-related issues such as errors and frequent changes were identified as key factors affecting project timelines. The results highlight the need for adopting effective project management practices, streamlining approval procedures, and strengthening coordination among stakeholders to mitigate delays. The outcomes of this study provide valuable insights for policymakers, engineers, and construction professionals to enhance decision-making and improve project delivery. Ultimately, addressing these delay factors is essential for achieving timely completion and ensuring sustainable infrastructure development in India.

Keywords— Public Infrastructure Projects, Delay Factors, Relative Importance Index (RII), Project Management

1.INTRODUCTION

Public infrastructure plays a vital role in the economic growth and social development of India by facilitating transportation, communication, water supply, and energy distribution systems. Over the past few decades, the Government of India has made substantial investments

in infrastructure development to support rapid urbanization and industrialization. However, despite these efforts, delays in public infrastructure projects have become a common and critical issue, leading to cost overruns, reduced efficiency, and compromised project outcomes. Timely completion of such projects is essential to ensure optimal utilization of resources and to meet the growing demands of the population [1].

Project delays in the Indian context are influenced by a wide range of factors, including land acquisition challenges, regulatory and approval processes, financial constraints, design changes, and poor project planning. In addition, inadequate coordination among stakeholders, lack of skilled labour, and unforeseen site conditions further contribute to schedule overruns. These delays not only affect project stakeholders but also have broader implications on economic productivity and public welfare [2].

Understanding the key delay factors and their relative significance is crucial for improving project performance [3]. Therefore, this study aims to identify and analyze the major factors causing delays in public infrastructure projects in India using quantitative methods such as the Relative Importance Index (RII). The outcomes of this research are expected to assist policymakers, engineers, and project managers in developing effective strategies to minimize delays and enhance the efficiency of infrastructure project delivery.

2.LITERATURE REVIEW

Previous studies on public infrastructure projects have consistently identified delays as a major challenge to project success. Researchers have highlighted poor planning, financial constraints, land acquisition issues, and inefficient contract management as primary causes of delays. Several studies have used analytical tools such as the Relative Importance Index (RII) to analyse these factors. The literature also emphasises the importance of effective stakeholder coordination and risk management practices to minimise delays and improve overall project performance in the construction industry.

Anurup et al. (2024) The existing research indicates that delays and budget overruns are persistent challenges in construction around the world, particularly in nations like India, where the average delay for postponed public infrastructure projects is quite considerable, surpassing 29 months. The analysis categorizes the root causes of delays into five main groups: Project, Contractor, Owner, Consultant, and External factors. By applying the Relative Importance Index (RII), findings reveal that the most significant contributing factors are Challenges in Securing Project Funding (RII=0.857) and Management of the Construction Site (RII=0.834), both of which are associated with contractors. Additional notable reasons encompass the Complexity of Project Construction (RII=0.771), Owner Payment Delays (RII=0.737), and Hold-ups in Securing Approvals (RII=0.760). These results collectively underscore the urgency for sound risk management strategies and prompt decision-making to alleviate delays in projects [4].

Anant et al. (2016) Establish that excessive costs and time delays are major, widespread challenges in construction and infrastructure initiatives across India, with only a limited number of projects completed on schedule and within financial constraints. This widespread challenge imposes substantial financial pressures on project stakeholders. Significant factors contributing to cost overruns noted in research include sluggish decision-making, ineffective schedule control, increasing prices of materials and machinery, and inadequate contract management. Regarding time delays, the main obstacle during the pre-execution stage involves holdups in land acquisition and handing over sites. Essentially, the absence of vital success elements such as thorough initial planning, proficient contractor abilities, and consistent coordination greatly exacerbates these systematic delays [5].

Siddhesh et al. (2013) The research indicates that significant delays and increased costs are common and serious features of infrastructure initiatives in India, due to their fundamental

risks and growing complexity. A study that pinpointed 73 reasons, classified into nine categories, identified the most pressing delay issues from the viewpoint of a contractor. These pressing issues encompass external influences such as subsurface conditions and workforce challenges including a lack of available workers. In addition, internal shortcomings like an inadequately short initial contract period, poor planning by contractors, and holdups in payment progress from the owner are primary systemic reasons that exacerbate this widespread issue [6].

Swadesh et al. (2017) The existing body of work indicates that delays in time and cost overruns are pervasive and significant obstacles within the Indian construction industry, notably influencing residential and high-rise developments. Investigations employing the Relative Importance Index (RII) consistently reveal that issues related to contractors and planning are the most significant contributors. The primary factors identified include the need for redoing work due to construction mistakes (RII=0.851), insufficient planning and scheduling efforts (RII=0.846), and the initial contract period being excessively brief (RII=0.811). Additional important elements involve delays in the delivery of materials and a lack of available labour. These postponements result in dire consequences for projects, including disputes, legal actions, and complete project cessation [7].

The following Table 1. Shows review of research paper and their key findings are from India and other countries.

Table 1. Review of research paper and their key findings

Sr. No.	Author(s) & Year	Country	Main Delay Factor	Key Findings
1	Ram Singh (2009)	India	Financial constraints	Financial issues major cause of infrastructure project delays[8]
2	Suraj Patil (2013)	India	Poor planning	Inefficient planning leads to transportation project delays[9]
3	Kartik Bagrecha et al. (2017)	India	Contractor inefficiency	Contractor performance significantly affects project completion time[10]
4	Siddesh Pai et al. (2013)	India	Land acquisition	Land issues critically delay infrastructure development projects[6]
5	Shete & Kothawade (2016)	India	Cost overruns	Time and cost overruns strongly interrelated in projects[11]
6	Pinky Devi & Sindhu (2025)	India	Coordination issues	Poor stakeholder coordination leads to major project delays[12]
7	Hamed Gohar et al. (2024)	Egypt	Risk management	Lack of risk planning causes delays and disputes[13]
8	Romzi & Doh (2022)	Malaysia	Multiple factors	Review identifies planning and management as key delays[14]
9	Bhadoria et al. (2017)	India	Scheduling problems	Improper scheduling significantly impacts project timelines[7]
10	Zhang (2005)	China	Financial risk	Financial risk impacts privatized infrastructure project performance[15]

3. RESEARCH METHODOLOGY

This study adopts a quantitative research approach to analyse the impact of delay factors in public infrastructure projects. The methodology is based on a structured questionnaire survey

and statistical analysis techniques to identify, evaluate, and rank the critical causes of project delays.

3.1 Data Collection

Primary data for this study were collected through a structured questionnaire survey designed to identify and evaluate delay factors affecting public infrastructure projects. The questionnaire was divided into major sections, including General Factors, Communication Gaps, Multi-Agency Coordination Failure, Financial Issues, Design Issues, Delay Due to Late Approvals.

Each section consisted of multiple variables (Q1–Q66), and respondents were asked to rate each factor on a five-point Likert scale ranging from: 1 = Very Low Impact; 2 = Low Impact; 3 = Moderate Impact; 4 = High Impact; 5 = Very High Impact.

3.2 Sample Size

The survey targeted professionals involved in public infrastructure projects, including project managers, site engineers, consultants, and contractors. A total of 75–80 valid responses were collected, ensuring a reliable dataset for analysis. The collected data were organized and processed using spreadsheet tools for further evaluation.

3.3 Relative Importance Index (RII) Method

The Relative Importance Index (RII) method was used to determine the significance of each delay factor and to rank them accordingly. Here Eq. (1) is for RII Method,

$$RII = \frac{\sum W}{A \times N} \quad \ldots\ldots (1)$$

Where:

W = weight assigned to each factor by respondents (1 to 5)
A = highest weight (5)
N = total number of respondents

The RII value ranges between 0 and 1. A higher RII value indicates a more significant delay factor. Based on the calculated RII values, all factors were ranked to identify the most critical causes of delay.

4.RESULTS ANALYSIS

The data collected from the questionnaire survey were analysed using statistical tools such as Mean Score and Relative Importance Index (RII). A total of 130 questionnaires were distributed, out of which 97 valid responses were received, resulting in a response rate of 74.61%, which is considered adequate for the study.

4.1 Stakeholder Distribution

Figure.1 illustrates the distribution of stakeholder roles involved in the study. Government Engineers/Academics/Researchers constitute 31% of the respondents, while Site Engineers/Quality Engineers represent 34%. Consultants/Design Engineers form the largest group at 35%, indicating balanced participation from all key professional categories in infrastructure projects.

Figure.2 shows the regional distribution of stakeholders, where 65% of respondents are from Surat and 35% from Navsari. This reflects a higher representation from moderately developed urban areas, providing diverse insights into project delay factors across different regional contexts.

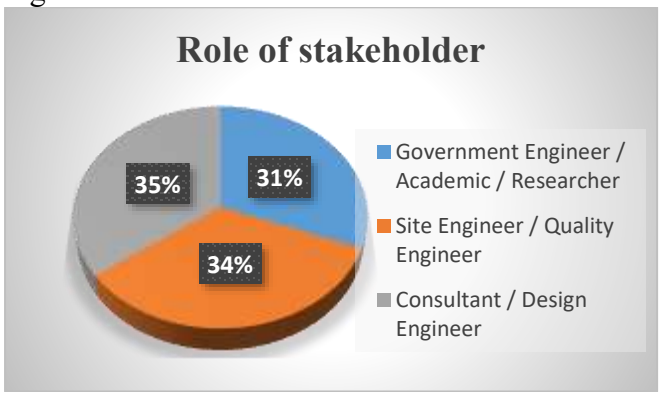

Figure.1. Role of Stakeholder wise distribution

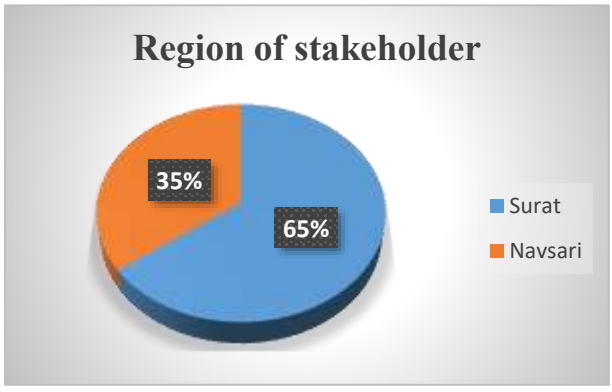

Figure.2. Region of Stakeholder wise distribution

4.2 RII Ranking of Factors with Discussion

The analysis of survey data collected from respondents was conducted using the Relative Importance Index (RII) method to evaluate and rank the critical delay factors affecting public infrastructure projects in India. The RII values obtained range from 0.618 to 0.859, indicating varying degrees of influence of different factors on project delays. Table 2. Shows the Factors with RII ranks and means respectively.

Table 2. RII Ranks & Mean of the Factor

Rank	No.	Factors	Mean	RII
1	C7	Approval conflicts between agencies delay implementation.	3.814	0.859
2	F1	Delay in statutory approvals causes project delay.	3.825	0.859
3	B3	Delayed response to site queries affects progress.	3.722	0.853
4	D8	Inflation significantly affects project timelines.	4.021	0.853
5	E11	Lack of constructability review leads to delay.	3.856	0.847
6	F9	Late approval of subcontractors causes delay.	3.928	0.841
7	A5	Project delays lead to disputes among stakeholders.	3.763	0.835
8	B1	Poor communication between client and contractor causes delays.	3.907	0.824
9	A11	Delays affect long-term sustainability of infrastructure projects.	3.814	0.818
10	F5	Late shop drawing approvals affect site execution.	3.804	0.818
11	C2	Delay in utility shifting by different agencies impacts project timeline.	4.021	0.812
12	E2	Errors in drawings lead to rework and delays.	3.711	0.812
13	F3	Delayed inspection approvals slow project progress.	3.907	0.806
14	E1	Frequent design changes cause project delays.	4.01	0.794
15	D10	Delayed bank approvals affect project cash flow.	3.835	0.788
16	E3	Incomplete design details affect construction progress.	3.866	0.788
17	D2	Cash flow problems of contractors affect project progress.	3.742	0.782

18	F6	Delayed approval of variation orders causes delay.	3.794	0.782
19	B11	Conflicts due to communication gaps delay work.	4	0.776
20	C6	Lack of interdepartmental meetings causes coordination failure.	3.887	0.776
21	A1	Project delays significantly affect overall project cost.	3.866	0.771
22	A2	Project delays significantly affect project quality.	3.701	0.771
23	A9	Unrealistic project timelines cause delays.	3.825	0.771
24	E5	Lack of coordination between design and execution teams causes delay.	3.814	0.771
25	F11	Digital approval systems could reduce project delays.	3.711	0.771
26	B2	Lack of clarity in project instructions contributes to delays.	3.856	0.765
27	F10	Bureaucratic procedures significantly delay projects.	3.598	0.765
28	A3	Project delays negatively impact public trust.	3.608	0.759
29	B6	Language barriers contribute to miscommunication.	3.742	0.759
30	C10	Overlapping responsibilities between agencies cause confusion.	3.639	0.759
31	D7	Delay in approval of revised estimates causes delay.	3.763	0.759
32	E8	Delayed approval of design revisions affects timeline.	3.887	0.759
33	A7	Inadequate project monitoring leads to delays.	3.711	0.753
34	D1	Delay in release of funds causes project delay.	3.856	0.753
35	E4	Late issuance of drawings causes delay.	3.835	0.753
36	E6	Design complexity increases project duration.	3.804	0.753
37	F2	Late building permit approvals affect project start.	3.68	0.753
38	F8	Delay in environmental clearance approvals impacts schedule.	3.835	0.753
39	C4	Conflicting instructions from multiple agencies delay work.	3.835	0.747
40	C11	Political interference between agencies causes delay.	3.711	0.747
41	D9	Financial disputes between stakeholders delay work.	3.814	0.747
42	B5	Poor coordination between site and head office causes delays.	3.588	0.741
43	B8	Lack of digital communication systems causes delays.	3.722	0.741
44	D3	Delayed payment to subcontractors impacts work speed.	3.711	0.741
45	E9	Inaccurate quantity estimation causes delay.	3.68	0.741
46	E10	Incompatibility between design documents causes confusion.	3.691	0.735
47	A4	Project delays increase administrative burden.	3.835	0.729
48	B7	Irregular progress meetings affect project timelines.	3.845	0.729
49	C3	Poor coordination with local authorities causes delays.	3.68	0.729
50	E7	Improper site investigation leads to design-related delays.	3.526	0.729
51	C1	Lack of coordination between government departments causes delays.	3.866	0.724
52	D6	Budget constraints affect timely completion.	3.639	0.724
53	F4	Delay in material approval causes work stoppage.	3.825	0.724

54	B4	Inadequate documentation leads to misunderstandings.	3.814	0.718
55	A8	Poor risk management contributes to delays.	3.557	0.712
56	D5	Poor financial planning contributes to delays.	3.598	0.712
57	A10	Inadequate site management results in delays.	3.722	0.706
58	C5	Delay in land acquisition from different authorities affects project progress.	3.742	0.706
59	D4	Escalation in material prices leads to delay.	3.814	0.694
60	F7	Slow decision-making by authorities affects timelines.	3.722	0.694
61	C9	Utility relocation issues significantly delay projects.	3.732	0.676
62	C8	Delayed environmental clearance affects project timeline.	3.464	0.671
63	A6	Lack of proper planning contributes to project delays.	3.608	0.665
64	D11	Inadequate financial risk management causes delays.	3.526	0.659
65	B10	Poor reporting systems lead to time overruns.	3.629	0.635
66	B9	Incomplete information sharing affects execution.	3.515	0.618

Table 3. Group wise average RII Rank

Factor Group	Description	Avg RII	Rank
F	Approval-related factors	0.79–0.82	1
D	Financial issues	~0.78	2
E	Design issues	~0.77	3
B	Communication gaps	~0.76	4
C	Coordination failure	~0.75	5
A	General factors	~0.74	6

The table 3. ranks major delay factors affecting public infrastructure projects based on Average Relative Importance Index (RII). Approval-related factors (F) are most critical (Rank 1), followed by financial issues (D) and design issues (E). Communication gaps (B), coordination failures (C), and general factors (A) have comparatively lower but still significant impact on project delays.

The results reveal that the most significant delay factor is “Approval conflicts between agencies delay implementation” (C7) and “Delay in statutory approvals causes project delay” (F1), both having the highest RII value of 0.859. This highlights that bureaucratic inefficiencies and multi-agency approval processes are the primary contributors to delays. These findings strongly reflect the complex administrative structure in Indian infrastructure projects, where multiple authorities are involved in decision-making.

Closely following these are “Delayed response to site queries affects progress” (B3) and “Inflation significantly affects project timelines” (D8) with RII values of 0.853, indicating that both communication inefficiencies and economic instability play a major role in delaying projects. Additionally, design-related issues, such as “Lack of constructability review” (E11) with an RII of 0.847, further emphasize the importance of proper planning and pre-construction evaluation.

Financial and approval-related constraints also appear prominently among the top-ranked factors. For instance, “Late approval of subcontractors” (F9) (RII = 0.841) and “Delayed bank approvals” (D10) (RII = 0.788) indicate that financial bottlenecks and procedural delays significantly hinder project progress. Similarly, cash flow problems of

contractors (D2) with an RII of 0.782 further reinforce the critical role of financial management in project execution.

Communication-related factors are consistently observed across the rankings. "Poor communication between client and contractor" (B1) with an RII of 0.824 and "Conflicts due to communication gaps" (B11) (RII = 0.776) demonstrate that ineffective communication channels lead to misunderstandings, rework, and delays. Moreover, issues such as lack of interdepartmental meetings (C6) (RII = 0.776) and overlapping responsibilities between agencies (C10) (RII = 0.759) highlight the importance of coordination among stakeholders.

Moderately ranked factors include issues related to planning and execution, such as "Unrealistic project timelines" (A9) (RII = 0.771) and "Inadequate project monitoring" (A7) (RII = 0.753). These findings suggest that insufficient planning and weak monitoring mechanisms contribute to delays but are comparatively less critical than approval and financial issues.

On the lower end of the ranking, factors such as "Incomplete information sharing" (B9) (RII = 0.618), "Poor reporting systems" (B10) (RII = 0.635), and "Inadequate financial risk management" (D11) (RII = 0.659) exhibit relatively lesser influence. Although these factors have lower RII values, they still contribute to inefficiencies and should not be overlooked.

The analysis indicates that approval-related delays, financial constraints, and communication gaps are the most critical factors impacting public infrastructure projects in India. The dominance of approval and coordination issues suggests a need for streamlining administrative procedures, enhancing inter-agency coordination, and adopting digital approval systems. Additionally, improving financial planning and strengthening communication mechanisms can significantly reduce project delays and improve overall project performance.

5.CONCLUSION

The following conclusion based on research work are as follows:

1. Approval and regulatory delays are the most critical factors, with inter-agency conflicts and slow statutory approvals (highest RII ≈ 0.859) significantly hindering project timelines, highlighting the need for streamlined approval systems.
2. Financial issues such as delayed funding, contractor cash flow problems, and late payments to subcontractors strongly impact project continuity, emphasizing the importance of effective financial planning and timely fund management.
3. Communication and coordination gaps among stakeholders, including poor client–contractor interaction and weak interdepartmental coordination, lead to inefficiencies and rework, indicating the need for stronger communication frameworks and digital tools.
4. Design-related challenges, including design errors, lack of constructability review, and frequent changes, moderately affect project progress, requiring better integration between design and execution phases.
5. Overall project delays result from a combination of administrative, financial, technical, and communication factors, suggesting that a holistic approach involving policy reforms, improved management practices, and technological adoption is essential for timely project completion.

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