OPEN ACCESS

Manuscript ID: MGT-2024-12027945

Volume: 12

Issue: 2

Month: October

Year: 2024

P-ISSN: 2321-4643

E-ISSN: 2581-9402

Received: 18.07.2024

Accepted: 04.09.2024

Published Online: 01.10.2024

Citation:
Kumar, Modish, and Santosh Kumari. "Empirical Study on Delays in Highway Projects: A Comparative Analysis of Small and Large Projects." *Shanlax International Journal of Management*, vol. 12, no. 2, 2024, pp. 15–25.

DOI:
https://doi.org/10.34293/management.v12i2.7945

Empirical Study on Delays in Highway Projects: A Comparative Analysis of Small and Large Projects

Modish Kumar
Research Scholar, Himachal Pradesh University Business School, Himachal Pradesh, India
https://orcid.org/0000-0002-2459-0637

Santosh Kumari
Assistant Professor, Himachal Pradesh University Business School, Himachal Pradesh, India

Abstract
Delays in National Highway projects, regardless of their geographical location, have exerted a substantial impact on project performance and yielded unfavourable economic consequences. The majority of these projects in India are implemented by Public-Private Partnerships (PPPs), which use a wide range of contract types, including traditional ones such as item rate contracts and bills of quantity, in addition to more modern alternatives such as build operate transfer, engineering procurement and transfer, and recently developed hybrid models. This study examines and compares the reasons of critical delays in national highway projects in Himachal Pradesh with project characteristics. This mixed-methods study gathered comprehensive data from project participants using qualitative analysis and a survey questionnaire. Interviews and document analysis identified delay factors, which were then assessed through a structured questionnaire distributed to a representative sample of project participants. The findings highlight critical delay factors in National Highway projects in Himachal Pradesh and offer insights into the unique challenges faced by large PPP projects and small traditional projects. Despite the small sample size of 134 survey responses, the findings are significant but may have limited applicability to other infrastructure projects due to socio-economic and geographic variations. This suggests a research gap indicating that further analysis is needed to understand the challenges in EPC and PPPs for large hilly road projects, along with a focused study on organizational culture to assess highway project performance. This study contributes empirical data to the literature about the steep National Highway projects in Himachal Pradesh. Policymakers, project specialists, and stakeholders may ascertain the reasons of delays and formulate targeted actions to enhance project efficiency.

Keywords: Comparison of Small and Large Projects, Delay, Himachal Pradesh, Mountainous Roads, National Highway Projects, Construction Project Delay

Introduction

Construction delays are a major contributor to productivity losses within the sector (Zarei et al.). The reasons of delays in construction projects vary according to project parameters, location, nation, and other variables (Sweis et al.; Aziz and Abdel-Hakam; Mahamid). A substantial number of studies have been undertaken about delays in various construction projects, including building, road, and oil and gas projects (Egwim et al.; Mbala et al.; Sanni-Anibire et al.). A systematic study conducted by Durdyev and Hosseini on delays in building projects indicated that prior research neglected essential elements related to contractual agreements, project culture, and delivery methodologies. Mbala et al. propose more study across many nations to ascertain the factors contributing to building project delays.

To gain a comprehensive understanding of delays, it is important to investigate them considering the limitations highlighted in the previous studies mentioned above. Hence, this study was conducted to investigate delays in highway projects that possess different characteristics within Himachal Pradesh, an Indian state located in the Himalayan region. The study, in the special context of unique geographic, socio-economic, and physical conditions of the state, provides valuable insights into construction project delays. This study focuses on National Highway projects executed in Himachal Pradesh from January 2015 to June 2023. According to the National Highway Act in India, both the state and central governments are responsible for the maintenance and development of national highways (MoRTH). In line with other states in India, Himachal Pradesh entrusts the maintenance and development of National Highway projects to both state and central government agencies.

Organizational culture denotes the collective beliefs, norms, values, attitudes, and assumptions that influence individuals' behavior inside the workplace (Arditi et al.). The organizational cultures of the HPPWD and the NHAI vary significantly. According to the competing values framework (CVF), the Himachal Pradesh Public Works Department (HPPWD) exhibits a hierarchical organizational culture, whereas the National Highway Authority of India (NHAI) demonstrates a market-oriented culture. The initiatives overseen by the HPPWD are executed using conventional contractual frameworks, including Engineering, Procurement, and Construction (EPC), Item Rate, or Bill of Quantities. The National Highway Authority of India (NHAI), the principal agency responsible for the central government highway project, implements initiatives through various Public-Private Partnership (PPP) models, including Build-Operate-Transfer (BOT), Hybrid Annuity Model (HAM), and Engineering, Procurement, and Construction (EPC), among others. Furthermore, the operational contexts of PPP and non-PPP projects are markedly different (Rajan et al.).

Table 1 Project and Operational Dynamics HPPWD and NHAI

Attributes	HPPWD	NHAI
Government	State Govt. (HP Govt.)	Road Transport and Highway Ministry, Govt. of India
Project Size	Small (50 Mn. INR to 100 Mn INR approx.)	Large (More than 1 Bn. INR)
Contract Type	Traditional (Item rates, BOQ, EPC)	PPP (BOT, HAM and EPC)
Area of operation	Himachal Pradesh	PAN (India)
Organisational culture	Hierarchy	Market

Note: Himachal Pradesh Public Works Department (HPPWD) and the National Highway Authority of India (NHAI)

Therefore, Highway projects implemented by the HPPWD and the NHAI offer a suitable case for investigating delay factors. This study attempts to address the research gap mentioned earlier by evaluating and comparing the key delay factors in the National Highway projects in Himachal Pradesh, which were carried out by the HPPWD and NHAI.

Literature Review

(Durdyev and Hosseini) systematically reviewed construction project delay studies from 1985 to 2018, revealing global trends and the top causes of delay. A meta-analysis by (Sanni-Anibire et al.) identified the top five delay factors including the contractor's financial difficulties and poor planning. In road projects, delays occur predominantly during earthwork, base work, and asphalt work (Mbala et al.; Mahamid). Poor site management and project complexity are pivotal causes of delays (Mbala et al). In Egypt, (Aziz and Abdel-Hakam) identified political situations and lowest-bid awards as primary delay factors. (Hoque et al.) identified progress payment delays, rework, and skilled labor shortages in Bangladesh. (Ansah and Sorooshian) introduced the 4P approach, which associates delays with project-related practices, participation, and procurement elements. Delays are classified into excusable, non-excusable, compensable, or non-compensable categories (Hamzah et al.; Kraiem and Diekmann). (Aziz and Abdel-Hakam) classified delays into categories: construction-related, managerial-related, political-related, financial-related, and technical-related factors. The literature analysis highlights the absence of agreement on the categorization of delay factors, stressing survey-based methodologies and the Relative Importance Index for their identification and prioritization (Hoque et al.; Mbala et al.; Rivera et al.; Sanni-Anibire et al.).

Scheduled variance is linked to project characteristics and organizational culture (Mahamid). Although not the main reason, organizational culture influences the impact of shared responsibilities on project delivery, with delay factors varying by country, location, and project type (Aziz and Abdel-Hakam). (Andersen) emphasised owner preparation and training for project success, whereas Arditi et al. noted significant owner contributions to delays in Indian construction projects. (Egwim et al.) highlight contractor and external factors for BIM-based project delay models. Successful PPP programmes in developing countries require a coordinating agency's understanding, active involvement, and skill-building facilitation (Mahalingam et al.). PPPs with shared risks result in shorter construction overruns, endorsing future BOT annuity projects (Gopalkrishna and Karnam).

(Alleman et al.) argues that alternative contracting methods (ACMs) are effective not only in small projects but also perform comparably to traditional models, suggesting that factors beyond project size influence the success of various delivery methods.

PPP highway projects outperform EPC projects in on-time completion, indicating technical and scale efficiency, potential government benefits, andno interest in payment obligations (Gopalkrishna and Karnam). Effective management of procurement risks in engineering projects is crucial for implementation within budgeted costs and time, and this study proposes a framework recommending varied strategies based on item types and risks. Mahalingam et al. explored how institutional factors shape PPP projects in Australia and India, revealing variations in sophistication and stressing the importance of aligning regulative elements with local conditions.

Research Methodology

This study used a mixed-methods approach to research that included both qualitative and quantitative approaches. This entails the successive implementation of a mixed-method approach (Pasian), commencing with a qualitative investigation, followed by a quantitative study. Interviews for the qualitative research were performed with participants from the NHAI and HPPWD projects. Data gathering using a theoretical sampling method, whereby information was amassed until saturation was achieved (Corbin and Strauss). Consequently, 14 interviews were performed, including seven people from each category of project participants. Furthermore, secondary data were obtained from various official websites, papers, news stories, and online sources, using N-Capture (QSR International) for data collection. Initially, we conducted a thematic content analysis using NVivo-12 software, employing a description-based coding technique (Adu) to discern significant delay drivers in National Highway projects in Himachal Pradesh. Qualitative data sources included interviews with project participants, official papers, media stories, checklists, and a literature study. Our study revealed a thorough compilation of 158 delay factors in the literature review. We conducted a qualitative study using the frequency of coding references to isolate these components, culminating in the discovery of 45 delay causes. Forty-five delay reasons were found in National Highway construction in Himachal Pradesh. The variables were further categorized into eight classifications (Tang et al.) according to prior research (Deep et al.; Abdul-Rahman et al.; Mahamid et al.; Rivera et al.). The classification of delay factors is in the categories of Contractor related delay factors; (CRDF) Consultant related delay factors; (ORDF) Owner related delay factors; (EDF) External delay factors; (PSDF) Project specific delay factors; (CMRDF) Contract Management related delay factors; (MMRF) Material and machinery related factors; and (LRDF) Labour related delay factors as shown in Figure 1.

Figure 1 Delay Factor in Compared by Number of Coding References

Secondly, the impact of the identified factors using a five-point Likert scale, which ranged from '1-Very low impact' to '5-Very high impact' was analysed. To collect data, we conducted a questionnaire survey involving 134 project participants who were currently engaged in Highway Projects in Himachal Pradesh. These participants were involved in projects under the authority of HPPWD or the NHAI; their profiles are shown in Table 2. A mixed-method approach to data collection was adopted, wherein the questionnaire was administered personally to respondents and sent via email through their respective authority offices. Approximately 45% of the entire population, which amounted to 134 respondents, responded positively and agreed to participate in the survey. The sample size of this study was adequate, with a confidence level of 95% and a probability (P) of 0.5to achieve a precision level of ±7%.

Profile of Respondents in Questionnaire Survey

The sample in this study was a fair representation of the entire population of project professionals working in Himachal Pradesh. A total of 134 respondents participated in this study, with 57 respondents belonging to projects under the authority of the HPPWD and 77 respondents involved in projects under the authority of the NHAI. Approximately 34% of owners, 37% of contractors, 29% of consultants, 30% held key project positions, and 86% held engineering degrees, as shown in tables 2, 3, and 4.

Table 2 Designations of Respondents in their Respective Organisation

Designation	Number
Engineer	63
Sr. Engineer	15
Manager	12
Project Manager	7
Team Leader	7
Project Director	5
Executive Engineer	5
Deputy Project Manager	4
General Manager	4
Superintendent Engineer	3
Deputy General Manager	2
Chief Engineer	1
Other	6
Total	**134**

Table 3 Educational Qualification and Work Experience of Respondents

Educational Qualification		Number of Years of Work Experience	
Bachelor's degree	63%	More than 15 years	27%
Master's Degree	22%	10-15 years	16%
Diploma	13%	5-10 years	28%
Other	1%	Less than 5 years	29%
Total	**134**	**Total**	**134**

Table 4 Representation in Terms of Roll and Project Management Knowledge

Role of Respondent's Organisations		Project Management Knowledge	
Consultant	29%	Educational degree	25%
Contractor	37%	Experience	59%
Owner (NHAI / HPPWD)	34%	Organisational Training	16%
Total	134	Total	134

This research used a 5-point Likert scale, it is essential to assess the reliability of the scale. A reliability test assesses the consistency of an instrument by determining if it yields same measurements upon repeated trials. Reliability was assessed using Cronbach's alpha to evaluate the internal consistency of the gathered replies. A Cronbach's alpha value over 0.7 is deemed acceptable. Consequently, attaining elevated Cronbach's alpha values is preferable, since increased values signify enhanced internal consistency of the scale. This research conducted a reliability test to evaluate the internal consistency of each component within the scale. The alpha coefficient for each construct exceeded 0.7, as seen in Table 5. This suggests that comments from a participant on a 5-point Likert scale on the causes of delays in National Highway projects in Himachal Pradesh would be consistent across related issues.

To offset the limitations of using either qualitative or quantitative methods alone, quantitative methods have been complemented with qualitative methods. Therefore, a mixed-method research approach has been used, combining both methods with interviews, document analysis and survey response of a sample size of 134 respondents. As this study relies on the experiential knowledge of respondents, it may introduce biases such as selection bias, respondent bias, and limited generalizability. All possible precautions have been taken to minimise bias and ensure proper representation of project participants; however, respondent bias can still occur as responses may be influenced by individual experiences, personal perspectives, and generalisability may be limited.

Table 5 Reliability Statistics of Cronbach Alpha Value for Each Construct

	Cronbach's Alpha	No of Items
CRDF1	.825	6
CRDF2	.808	4
ORDF	.790	8
MMRF	.859	4
LRDF	.833	4
EDF	.720	6
PSDF	.796	8
CMRDF	.759	5

Note: (CRDF1) Contractor related delay factors; (CRDF2) Consultant related delay factors; (ORDF) Owner related delay factors; (EDF) External delay factors; (PSDF) Project specific delay factors; (CMRDF) Contract Management related delay factors; (MMRF) Material and machinery related factors; and (LRDF) Labour related delay factors.

Data Analysis

The degree of delay in the project was analyzed by comparing the schedule variance of 22 different projects that have experienced delays, and to make comparison the delay was standardized using the formula for scheduled variance (SV) in Equation 1 (Leybourne et al.; Przywara and Rak).

SV = BCWP−BCWS,

BCWP = Budgeted cost of work performed,

BCWS = Budgeted cost of work scheduled

$$SV_{\%age} = (SV/BCWC) \text{ X } 100 \qquad (1)$$

The projects considered in this study, along with the degree of project delay, are shown in terms of percentage schedule variance in Appendix 1. The projects under HPPWD exhibit a lower average degree of project delays at a 38% Schedule Variance compared to NHAI projects, which have a 61% average Schedule Variance. This difference was statistically tested. Because there is a substantial difference between the percentage variances of projects under HPPWD and NHAI, the subsequent step is to conduct a thorough examination of the factors contributing to delays in these projects. The subsequent part of this section elucidates the data analysis pertaining to this aspect.

Responses to the questionnaire were analyzed using the Relative Importance Index (RII). RII has also been utilized to analyze the causes of delay in previous studies (Aziz and Abdel-Hakam; Kazaz et al.; Khoshgoftar et al.; Sanni-Anibire et al.). The formula for Relative Importance Index (γ_k) is given in Equation 2.

$$\gamma_k = \{(\sum \lambda_i \times \alpha_{ik})/(A \times N)\} \times 100 \qquad (2)$$

Here, γ_k indicates the relative importance index (RII) of the k^{th} item, and λ_i is the frequency of the i^{th} response for the α_i value in the i^{th} response. The numerator of the formula comprises the following two variables. First, $\alpha_{i.k}$ represents the numerical value assigned to the i^{th} response for the k^{th} item, which can vary between 1 and 5, based on the impact level chosen by the respondents. Second, λ_i represents the frequency of $\alpha_{i.k}$ within the total number of responses for the k^{th} delay factor.

The denominator of the formula includes two constants. Represents the highest weight assigned to a response (in this case, it is 5), indicating the maximum possible impact level. N represents the total number of respondents who participated in the questionnaire survey.

Based on the score obtained from the RII analysis for the impact of causes of delays on the Likert scale, the top five critical factors that have the highest impact on delays in Highway Projects in Himachal Pradesh are: (1) forest clearances (γ_{18}=84.18); (2) land acquisition (γ_{15}=79.55); (3) weather conditions (heavy rains, snowfall, and floods (γ_{28}=75.37)); (4) land issues (demarcation, encroachments, and cultivable land near γ_{44}=70.00); and (5) landslides (γ_{32}=69.55). The values of γ_k for all remaining delay factors are shown in Figure 1. The impact of each delay factor in the project under the authority of the HPPWD is represented by a black line, while the impact of each delay factor in the project under the authority of the NHAI is represented by a red line. In Figure 2, the lighter yellow line represents the overall impact of delay factors on National Highway projects in Himachal Pradesh. The top three delay factors with highest γ_k values are same in both kinds of projects, these top three critical delay factors are: (1) Forest clearances ($\gamma_{11\ HPPWD}$=86.21, $\gamma_{11\ NHAI}$=81.56); (2) Land acquisition ($\gamma_{15\ HPPWD}$=75.52, $\gamma_{15\ NHAI}$=81.56); (3) Weather condition (heavy rains, snowfall and floods ($\gamma_{28\ HPPWD}$=74.83, $\gamma_{28\ NHAI}$=74.81).

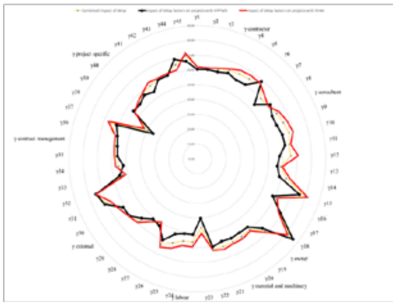


Figure 2 Impact of Each Delay Factor

The remaining factors, ranked by γ_k, differed between the HPPWD and NHAI projects, as detailed in Tables 6 and 7. Figure 3 depicts the comparative ranking and importance of delay factors, with black bars representing HPPWD, red bars representing NHAI, and yellow bars indicating overall importance in Himachal Pradesh's National Highway projects. Despite the similarities in the rankings of the top three factors, variations exist in their λi values. A non-parametric Mann-Whitney U test was applied to compare two independent groups, considering the ordinal scale of the Likert data.

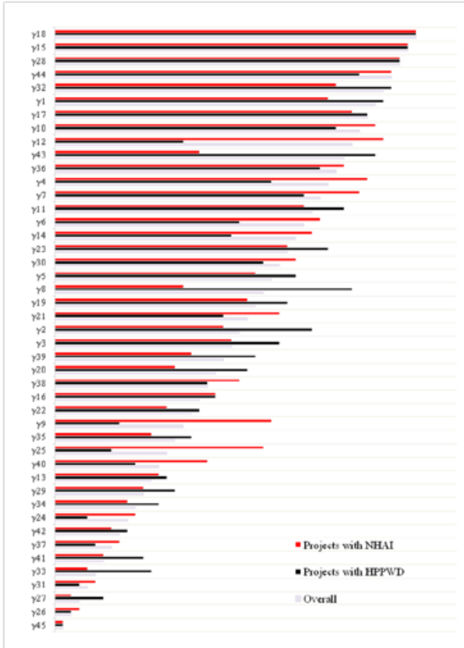


Figure 3 Relative Importance of Delay Factors

Table 6 Top 15 Critical Delay Factors in Projects under HPPWD

Category type	Delay factor	γ_k	Ranking (HPPWD)
Owner related factor	Forest clearances	86.21	1
Owner related factor	Land acquisition	75.52	2
External factor	Weather condition (heavy rains, snowfall and floods)	74.83	3
External factor	Land slides	71.72	4
Owner related factor	Utility shifting work	68.97	5
Project specific factors	Interruption due to traffic	68.97	6
Contractor related delay factor	Poor planning and scheduling of the project by the contractor	68.62	7
Project specific factors	land issues (demarcation, encroachments, and cultivable land nearby)	66.21	8
Consultant related delay factor	Design error, lack of design work and lack of design information	62.76	9
Owner related factor	Obtaining approvals from owner	62.07	10
Consultant related delay factor	Inaccurate survey of the site	61.72	11
External factor	Force majeure -- uncontrollable external factors, natural disaster	61.38	12

Contract Management	Award project to lowest bid price	61.03	13
Contractor related delay factors	Contractor's financial difficulties	60.69	14
Contractor related delay factors	Inappropriate construction methods and rework due to construction mistakes	60.34	15

Table 7 Top 15 Critical Delay Factors in Projects under NHAI

Category type	Delay factor	γk	Ranking (HPPWD)
Owner related factor	Forest clearances	81.56	1
Owner related factor	Land acquisition	81.56	2
External factor	Weather condition (heavy rains and floods)	74.81	3
Project specific factors	land issues (demarcation, encroachments, and cultivable land nearby)	71.95	4
Owner related factor	Changes in scope, specifications, orders, drawing etc. by owner	70.65	5
Consultant related delay factor	Inaccurate survey of the site	69.35	6
Consultant related delay factor	Delays in approval of drawings, inspection, changes, specification and material samples etc. by consultants	67.79	7
Contractor related delay factors	Lack of experience and incompetent technical staff of contractor	67.53	8
Contractor related delay factors	Poor planning and scheduling of the project by the contractor	67.27	9
Contract Management	Award project to lowest bid price	67.27	10
External factor	Land slides	67.01	11
Owner related factor	Utility shifting work	67.01	12
Contractor related delay factors	Poor site management and supervision	67.01	13
Owner related factor	Slow decision making from owner	66.49	14
Owner related factor	Obtaining approvals from owner	65.97	15

To determine whether there was a statistically significant difference in the γ_k value of the delay factors between the two groups, the following hypotheses were formulated: The Mann-Whitney U test for all items was performed using the Statistical Package for Social Sciences (SPSS version 25.0) for Windows.

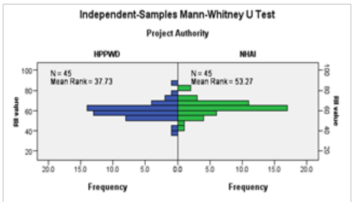
Null Hypothesis (H_0): There is no significant difference in the γ_k values between Projects with HPPWD and Projects with NHAI.

Alternate Hypothesis (H_1): There is a significant difference in the γ_k value between projects with HPPWD and NHAI.

Rejection of Null Hypothesis Test Summary

Null Hypothesis	Test	Sig.	Decision
The distribution of RII value is the same across categories of Project Authority.	Independent-Samples Mann-Whitney U Test	.005	Reject the null hypothesis

Based on the Mann-Whitney U test ($\alpha = 0.005$), the null hypothesis was rejected. NHAI's γ_k ranges from 42.5 to 82.5, and HPPWD's from 37.5 to 87.5, indicating notable differences in the delay impact between the two types of projects.



Total N	90
Mann-Whitney U	1,362.000
Wilcoxon W	2,397.000
Test Statistic	1,362.000
Standard Error	123.892
Standardized Test Statistic	2.821
Asymptotic Sig. (2-sided test)	.005

Figure 4 Mann-Whitney U Test

Findings

After conducting site visits, site visits, interviews, and thorough data analysis, it is evident that there are many problems with the cause of delay factors in the National Highway projects in Himachal Pradesh. The top three factors were the same in both the NHAI and HPPWD projects.

For forest clearance and land acquisition, both projects undergo similar processes governed by legal frameworks, but outcomes may differ based on project size, location, and cooperation, involving multiple stages and complexities. Regarding Weather Conditions, both agencies, working in hilly regions, face similar difficulties, such as heavy rains, snowfall, and floods, leading to potential infrastructure damage and traffic disruptions. Delay mitigation depends on project design, quality, maintenance, and the effectiveness of contingency and disaster management plans.

In mountainous regions, such as Himachal Pradesh, challenges such as landslides, utility relocation, and traffic disruptions can result in delays and cost overruns in road construction. Projects under the HPPWD, often smaller with less robust design standards and inefficient practices in utility shifting, traffic management, and public awareness, may be more significantly impacted by these issues. Delays in hilly projects can be caused by several factors, particularly in larger and more intricate projects. These include land difficulties, scope changes, faulty surveys, and delays in approval. Since projects under NHAI are bigger in size, need more coordination, and include more stakeholders than projects under HPPWD, these difficulties may disproportionately affect projects under NHAI. The complexity of larger projects, with various terrains and regulatory permissions, increases the potential impact of erroneous surveys and delays in approval procedures. A lack of contractor experience in hilly terrain and insufficient technical staff can impact NHAI project implementation more, especially in larger, complex projects requiring specialized expertise. Poor planning and scheduling pose challenges, particularly in major NHAI projects with complex scope and stringent quality control requirements.

In HPPWD projects, inadequate design information, design errors, and poor communication are the result of less experienced consultants and a less rigorous review procedure. Administrative procedures can lead to delays in owner approval, which may result in disputes. Inaccurate site surveys also affect planning and design. Owing to insufficient contingency planning, force majeure incidents may cause delays in HPPWD projects, affecting performance. Awarding projects to the lowest bid price potentially contributes to delays in both EPC and PPP National Highway projects but in different ways. In both cases, it affects the contractor's motivation and efficiency. Low bids may result in inadequate profit margins and sacrifices in project quality in EPC projects where the contractor carries a significant amount of risk and expenditure. Failure of a project to meet contract parameters may lead to disputes with the government. Abnormally Low bids might affect the private partner's capacity to carry out the project effectively, which could cause delays in PPP projects in which risks and expenses are shared.

There are dissimilarities between the two project authorities, HPPWD and NHAI, due to differences in their organizational cultures and the characteristics of the projects they undertake. HPPWD mostly executes small projects within Himachal Pradesh, primarily using traditional contracts, whereas NHAI handles large-scale projects across India under various forms of public-private partnerships. Upon comparing the rankings and γ_k values for delay factors between HPPWD and NHAI, it can be deduced from the mean γk value of NHAI and

HPPWD projects that the delay factors have a greater impact on larger projects. The results of the Mann-Whitney test highlight that despite the similarity in the top three ranks of delay factors in each group, the impact values for each factor differ, and their ranking order is also different. Therefore, mitigating these delay factors requires a different approach, as the impact of causal factors differs between the two groups of projects.

Recommendations

Based on the analysis of both qualitative and quantitative research, practical recommendations can be suggested to effectively minimize delays in National Highway Projects located in hilly areas, enhancing overall project efficiency and timely completion.

Five Essential Strategies to reduce Project Delays are as Follows

Streamlining Approvals: For both NHAI (large-scale) and HPPWD (small-scale) projects, streamline approvals from government agencies and clearances for forest land and environmental issues to expedite necessary permits. Ensure coordination between stakeholders to reduce bureaucratic inefficiencies through timely collaboration, proactive follow-ups, and effective communication

Develop Robust Contingency Plans: Since external factors delay projects, develop robust contingency plans to address adverse weather and landslides. For both large and small projects, implement flexible Planning&scheduling, proactive land management, and protective measures against natural disruptions to bolster resiliency.

Ensure Accurate Preconstruction Surveys: In the preconstruction stage, ensure thorough and accurate site surveys and design work to prevent consultant errors from delaying approvals. Follow a rigorous review process to avoid inaccuracies, thereby reducing scope changes and modifications in drawings and design.

Select Contractors Based on Expertise: For large-scale NHAI projects, prioritize contractors based on technical expertise rather than the lowest bid. Ensure detailed planning and scheduling to prevent delays, and employ experienced staff familiar with the region's topography and working conditions to avoid poor management. Small-scale HPPWD projects should also adopt this strategy for better efficiency.

Manage Scope Changes Efficiently: Establish clear protocols for managing scope changes, specifications, and utility shifting work for both large and small projects. Ensure that changes are well-documented, communicated, and integrated into the project plan without causing significant delays. Prioritize comprehensive planning for small-scale projects and enforce rigorous planning and scheduling for large PPP projects in hilly areas.

Conclusion

This study aimed to analyze the impact of delay factors in projects implemented by two different project authorities, HPPWD and NHAI, which differ in project size, contract type, and organizational culture. The study employed a mixed-method approach by collecting data through interviews, questionnaires, official documents, and websites. Qualitative data were analysed using NVivo-12 software and quantitative data were analysed using SPSS software.

Delays in National Highway projects in Himachal Pradesh, governed by the NHAI and HPPWD, result from forest clearances, incomplete land acquisition, changing weather patterns, and various project-specific factors. Because of their larger size, NHAI projects face additional delays owing to scope changes, land issues, survey inaccuracies, approval delays, inexperienced contractors in hilly terrain, and low bid prices, differing in impact and ranking from HPPWD projects. In conclusion, this study shows that NH projects in Himachal Pradesh under the NHAI and HPPWD have similar problems. Delays are influenced by several factors, including project scale, weather, land acquisition, and forest clearances. However, because of the substandard methods, smaller HPPWD projects are more prone to delays. NHAI projects, primarily bigger ones, encounter particular issues relating to scope changes and lack of contractor experience in mountainous terrain, despite the fact that they also face challenges related to weather and approval. This study supports the findings of previous studies, such as (Gopalkrishna and Karnam), indicating that Public-

Private Partnerships (PPPs) like BOT are more efficient in the timely delivery of relatively larger projects. However, in the case of hilly terrain such as Himachal Pradesh, opting for a smaller EPC project may, in some cases, turn out to be a better option than PPPs for timely project delivery. Therefore, the need for customized mitigation strategies increases because project characteristics and organizational culture (Mahamid) differ, aligning regulation to local conditions (Devkar et al.). To minimize delays in National Highway Projects in hilly areas, project implementing agencies must streamline approvals, develop robust contingency plans for environmental issues, ensure accurate preconstruction surveys, select contractors based on expertise, and manage scope changes efficiently. Additionally, prioritise experience for large PPP projects over lowest bid and comprehensive planning for small-scale projects.

Limitations and Future Research

The applicability of the findings of this study to other types of infrastructure projects in different contexts may be limited owing to variations in the socio-economic and geographic conditions of the project locations. Further analysis and investigation are required to better understand the challenges associated with EPC and PPPs with regard to large hilly road projects. It is also recommended to conduct a study specifically focused on organizational culture to assess the overall performance of highway projects. To address the limitations of using either qualitative or quantitative methods alone, this study employed a mixed-methods approach. It has been ensured that the sample properly represents project participants in this study. Despite all possible efforts to minimize biases, the reliance on respondents' experiential knowledge may still introduce biases and limit generalizability.

References

Abdul-Rahman, Hamzah, et al. "Financial-related Causes Contributing to Project Delays." *Journal of Retail and Leisure Property*, vol. 8, 2009, pp. 225-38.

Adu, Philip. *A Step-by-Step Guide to Qualitative Data Coding*. Routledge, 2019.

Alleman, Douglas, et al. "The Use and Performance of Alternative Contracting Methods on Small Highway Construction Projects." *Procedia Engineering*, vol. 145, 2016, pp. 908-15.

Andersen, Erling S. "Illuminating the Role of the Project Owner." *International Journal of Managing Projects in Business*, vol. 5, no. 1, 2012, pp. 67-85.

Ansah, Richard Hannis, and Shahryar Sorooshian. "4P Delays in Project Management." *Engineering, Construction and Architectural Management*, vol. 25, no. 1, 2018, pp. 62-76.

Arditi, David, et al. "Effect of Organizational Culture on Delay in Construction." *International Journal of Project Management*, vol. 35, no. 2, 2017, pp. 136-47.

Aziz, Remon F., and Asmaa A. Abdel-Hakam. "Exploring Delay Causes of Road Construction Projects in Egypt." *Alexandria Engineering Journal*, vol. 55, no. 2, 2016.

Corbin, Juliet, and Anselm Strauss. *Basics of Qualitative Research*. Sage Publications, 2008.

Deep, Shumank, et al. "Critical Factors Influencing the Performance of Highway Projects: Empirical Evaluation of Indian Projects." *Buildings*, vol. 12, no. 6, 2022.

Durdyev, Serdar, and M. Reza Hosseini. "Causes of Delays on Construction Projects: A Comprehensive List." *International Journal of Managing Projects in Business*, vol. 13, no. 1, 2020, pp. 20-46.

Egwim, Christian Nnaemeka, et al. "Systematic Review of Critical Drivers for Delay Risk Prediction: Towards a Conceptual Framework for BIM-Based Construction Projects." *Frontiers in Engineering and Built Environment*, vol. 3, no. 1, 2022, pp. 16-31.

Gopalkrishna, Nagesha, and Gayithri Karnam. "Are the Indian National Highway PPPs more Efficient than Non-PPPs? An Empirical Analysis through Data Envelopment Analysis." *Journal of Infrastructure Development*, vol. 8, no. 1, 2016, pp. 27-35.

Hamzah, N., et al. "Cause of Construction Delay - Theoretical Framework." *Procedia Engineering*, vol. 20, 2011, pp. 490-95.

Hoque, Md Ikramul, et al. "Analysis of Construction Delay for Delivering Quality Project in Bangladesh." *International Journal of Building Pathology and Adaptation*, vol. 41, no. 2, 2023, pp. 401-21.

Kazaz, Aynur, et al. "Causes of Delays in Construction Projects in Turkey." *Journal of Civil Engineering and Management*, vol. 18, no. 3, 2012, pp. 426-35.

Khoshgoftar, Mohammad, et al. "Causes of Delays in Iranian Construction Projects." *International Journal of Construction Management*, vol. 10, no. 2, 2010, pp. 53-69.

Kraiem, Zaki M., and James E. Diekmann. "Concurrent Delays in Construction Projects." *Journal of Construction Engineering and Management*, vol. 113, 1987, pp. 591-602.

Leybourne, Steve A., et al. "Is Project Management the New Management 2.0?." *Organisational Project Management*, vol. 1, 2014, pp. 16-36.

Mahalingam, Ashwin, et al. "A Comparative Analysis of Public-Private Partnership (PPP) Coordination Agencies in India." *Public Works Management and Policy,* vol. 16, no. 4, 2011, pp. 341-72.

Mahamid, Ibrahim. "Analysis of Schedule Deviations in Road Construction Projects and the Effects of Project Physical Characteristics." *Journal of Financial Management of Property and Construction*, vol. 22, 2017, pp. 192-210.

Mahamid, Ibrahim. et al. "Causes of Delay in Road Construction Projects." *Journal of Management in Engineering*, vol. 28, no. 3, 2012, pp. 300-10.

Mbala, Mbuyamba, et al. "Causes of Delay in Various Construction Projects: A Literature Review." *Advances in Intelligent Systems and Computing*, vol. 788, 2019, pp. 489-95.

Pasian, Beverly, and Rodney Turner. *Designs, Methods and Practices for Research of Project Management*. Routledge, 2016.

Przywara, Daniel, and Adam Rak. "Monitoring of Time and Cost Variances of Schedule using Simple Earned Value Method Indicators." *Applied Sciences*, vol. 11, no. 4, 2021.

QSR International. *NCapture (Version 1.0. 178.0)*. 2011.

Rajan, Thillai A., et al. "PPPs and Project Overruns: Evidence from Road Projects in India." *Journal of Construction Engineering and Management*, vol. 140, no. 5, 2014.

Rivera, Ludwig, et al. "A Study on Causes of Delay in Road Construction Projects across 25 Developing Countries." *Infrastructures*, vol. 5, no. 10, 2020.

Sanni-Anibire, Muizz O., et al. "Causes of Delay in the Global Construction Industry: A Meta Analytical Review." *International Journal of Construction Management*, vol. 22, 2020.

Sweis, G., et al. "Delays in Construction Projects: The Case of Jordan." *International Journal of Project Management*, vol. 26, no. 6, 2008, pp. 665-74.

Tang, Wenzhe, et al. "Risk Management in the Chinese Construction Industry." *Journal of Construction Engineering and Management*, vol. 133, no. 12, 2007, pp. 944-56.

Zarei, Behrouz, et al. "Delay Causes Analysis in Complex Construction Projects: A Semantic Network Analysis Approach." *Production Planning & Control*, vol. 29, no. 1, 2018, pp. 29-40.

Author Details

Modish Kumar, *Research Scholar, Himachal Pradesh University Business School, Himachal Pradesh, India,*
Email ID: *modish.005@gmail.com*

Dr. Santosh Kumari, *Assistant Professor, Himachal Pradesh University Business School, Himachal Pradesh, India,*
Email ID: *drsantoshkumari87@gmail.com*