

Perceptual Analysis of Delay Factors in Highway Construction Projects: Insights from Projects in Hilly Terrains

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ABSTRACT

This study analyses the perceptions of owners, contractors, and consultants towards delays in highway projects in the hilly terrains Himalayan region. The research aims to uncover the nuanced views of these key stakeholders, which have been underexplored in existing literature, in light of the region's unique geographical challenges. The study employed a mixed-methods approach, utilising NVivo 14 for qualitative data analysis and Python for quantitative analysis, specifically the Kruskal-Wallis test, to examine the perception gap concerning 45 items on a five-point Likert scale questionnaire. The findings reveal that most items show overall agreement in perceptions, while 13 items exhibit significant perception gaps, suggesting the need for tailored management strategies to mitigate delay factors specific to hilly regions. This research contributes to the body of knowledge by providing a context-specific understanding of project delays, which is crucial for developing effective risk management practices in the construction industry.

Keywords: *Highway project delays; Stakeholder perceptions; Hilly terrain construction; Himalayan infrastructure; Road projects.*

1.0 Introduction

The views of owners, contractors, and consultants align and differ, influencing how construction projects unfold in these mountains' region. The rugged topography of hilly terrain, unpredictable weather, and limited accessibility contribute to the complexity of construction activities (Shukla et al., 2023).

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Therefore, this study conducts a comprehensive analysis that takes into account the distinct perspectives and interests of project participants, including owners, consultants, and contractors, regarding delays in road construction projects. The significance of this study lies in its potential to inform better management practices and policy-making for highway projects in hilly regions. By identifying the specific causes of delays and understanding stakeholder perceptions, the study can contribute to the development of targeted strategies to mitigate risks and ensure timely project completion (Akomah & Jackson, 2016; Rivera et al. 2020). This is particularly important for regions like Himachal Pradesh, where efficient transportation infrastructure is vital for economic growth and community well-being (Ametepey et al., 2023).

This study aims to bridge the knowledge gap by examining the interplay between these perceptions and the distinctive features of hilly terrains that influence project timelines (Mehta et al., 2022). It seeks to identify the factors perceived to contribute to these delays, assess their differences, and examine the unique challenges of such projects. The study also aims to contribute to the broader discourse on project management in complex geographical settings (Sharma et al., 2021). The primary objective of this study is to analyse the perceptions of key stakeholders – i.e. owners, contractors, and consultants -- towards delays in highway projects situated in hilly terrains, and to highlight the key differences in their perceptions with respect to each delay factor. Additionally, the study aims to study:

1. To evaluate the relative importance of delay factors as perceived by three key stakeholders' group.
2. To determine if there are statistically significant differences in stakeholder perceptions.
3. To study delay factors and providing managerial recommendations for mitigating project delays in infrastructure projects under complex geographical and environmental conditions.

2.0 Literature Review

According to the stakeholder theory, the performance outcomes that occur as a result of project activities are impacted by various stakeholder interests. Analysis of the delay factors and their potential effect on the project will be examined through stakeholder perspectives. Effective project management and mitigation strategies require an understanding of the perspectives held by contractors, consultants, owners, and other stakeholders regarding project delays, which are one of the major problems in the construction sector (Al Saeedi & Karim, 2022; Çevikbaş & Işık, 2021).

Construction professionals, Contractors, including project managers and site engineers, often perceive delays as a result of logistical challenges, resource shortages,

changes in scope by clients, and operational inefficiencies (Mehta et al., 2022; Shahsavand et al., 2018). They advocate for better project planning and resource management to mitigate these issues. Consultants, including architects and engineering firms, view delays from a technical perspective, focusing on design complexities, regulatory approvals, and coordination among various parties.

They emphasised the importance of clear communication and early involvement in the planning stages (Shaban et al., 2024; Shahsavand et al., 2018). Owners prioritise financial ramifications of delays, like cost overruns and revenue loss, stressing adherence to timelines and the pivotal role of contractual agreements in managing expectations and responsibilities (Abdul-Rahman et al., 2009; Mejía et al., 2023; Mehta et al., 2022). Other stakeholders, including suppliers, subcontractors, and government agencies, hold unique perspectives on project delays, with suppliers concerned about inventory costs, and government agencies concentrating on regulatory compliance and public safety (Khahro et al., 2023; Mejía et al., 2023; Yang et al., 2023).

Despite the growing body of literature on stakeholder perceptions in construction projects, there is a notable lack of context-specific analysis concerning highway projects in hilly road projects. The distinctive geographical and socio-economic conditions of the region require a focused investigation into the perceptions of owners, contractors, and consultants to develop tailored project management strategies that tackle local challenges (Ametepey et al., 2023; Mehta et al., 2022). This research gap highlights the necessity for empirical studies to comprehend how stakeholder perceptions intersect with project outcomes in the Himalayan terrain, where environmental and logistical factors notably impact project execution (Esperilla-Niño-de-Guzmán et al., 2024; Nyandika & Ngugi, 2014).

To develop effective project management and delay mitigation strategies, first it is necessary to understand how owners, consultants and contractors view the common causes of delay (Akinsiku & Akinsulire, 2012). In general, construction delays are mostly agreed to negatively impact cost, time and quality-performance of projects (Kumar & Kumari, 2022; Rivera & BaguecJr, 2020; Sanni-Anibire et al., 2020). In the long-term delays in construction continue to pose a problem for infrastructure projects. Beside acknowledging delays as a universal phenomenon, the researchers have identified a large number of factors causing these delays like poor planning and scheduling, lack of communication, shortage of labour and resources, conflict of interest of project parties and many others (Kumar & Kumari, 2025).

These studies demonstrate that owners, contractors and consultants view the cause of delays differently as well as their relative importance. The logistics and weather conditions of the region will act as a constraint. Furthermore, they will increase traditional delays occurring in other geographies. A systematic review, for example, highway and road construction project faces causes of delays similar to other types of civil infrastructure project (Kumar & Kumari, 2025; Rivera et al., 2020).

The study undertaken by Karunakaran et al., (2018) and Kumar & Kumari, (2023) highlighted the numerous mixtures of the government, consultants, and contractors that are responsible for the delay of contractors. However, none of the review papers seem to show enough emphasis on, bad weather, access to the site, and coordination issues under the difficult geographical conditions. The literature review and qualitative findings informed the study objectives, thus providing a basis for the questionnaire design. As such, the empirical analysis conducted is able to attempt to address the research gap.

3.0 Research Methodology

The preliminary research was conducted using qualitative methods to explore the perceptions of stakeholders towards project delays (Creswell, 2009). The study used data triangulation with multiple sources of data for preliminary qualitative data analysis, including primary data from 17 recorded interviews, 240 official documents of 4 highways projects, images of project sites, and checklists; secondary data from notifications, reports, official websites (National Highway Authority India, Himachal Pradesh Public Works Department, Ministry of Road Transportation and Highway), media reports, and media interviews. The qualitative data were then analysed using NVivo 14 software, which facilitated the organisation, coding, and thematic analysis of the data (Allsop et al., 2022).

The literature review, along with insights from the qualitative analysis, informed the development of a comprehensive questionnaire. The questionnaire was designed to capture a wide range of factors contributing to project delays as perceived by the stakeholders. A Likert scale format was adopted for the questionnaire, consisting of 45 items, allowing respondents to express the degree of their agreement or disagreement with each statement (Artino Jr et al., 2014). The responses on the questionnaire were collected from 213 project participants (52 owners, 87 contractors, 70 consultants), and the Kruskal-Wallis's test using Python. This scale measured the degree of delay impact by various factors through statements related to delay factors. Kruskal-Wallis test (Kruskal and Wallis, 1952; Vohra, 2019), a non-parametric statistical analysis method, to determine if there are statistically significant differences between the medians of the perceptions of the three stakeholder groups.

The Kruskal-Wallis's test (Kruskal & Wallis, 1952) was chosen for its suitability for ordinal data, such as that obtained from Likert scales, and its robustness in handling non-normal distributions, which are common in survey data with smaller sample sizes. This test is particularly advantageous as it can handle data from multiple groups with different sample sizes (James T. McClave, P George Benson, 2021). This method is appropriate for comparative analysis of perceptions among owners, contractors, and consultants with respect to delay factors in this study. Data from structured questionnaires using this technique is used

to access variations in opinions in other words to identify significant perceptual differences, and provides an objective basis for understanding stakeholder perspectives towards delay factors in highway projects situated of hilly areas (Kruskal & Wallis, 1952). The perceptions of owners, contractors, and consultants were quantitatively analysed using the Kruskal-Wallis test in Python (*Scipy.Stats.Kruskal — SciPy v1.13.1 Manual*, n.d.). This non-parametric test was chosen as it does not assume a normal distribution of the data and is suitable for comparing medians across multiple groups⁴. The test was applied to all 45 items in the questionnaire.

For this study questionnaire was developed by adopting a multi-stage approach. To determine most commonly reported delay factors from literature review were identified and after that, using NVivo 14 for preliminary qualitative analysis to delay the study's qualitative evidence and the data composed of 17 interviews and press conferences with project participants. A panel of experts was approached for validation of this first list of factors. Construction management project managers were also invited to review the delay factor list. They were selected because they are the construction and academic experts and the most topical knowledgeable and experienced in this area. The experts confirmed the applicability, comprehensibility, significance and comprehensiveness of the parameters.

The quantitative methodology used in the survey data which collected from 200 respond represent three stakeholder groups. The delay factors perception measured using a Likert scale and utilizing the Python Statistical Package, the data was analysed and tested using Kruskal–Wallis test that does not require to assume the samples is normally distributed as the sample is relatively small. In addition, since we have more than two groups of independent samples, so comparing their perceptions by employing Kruskal-Wallis's test is the most appropriate here. The test provides results with statistically significant differences from Stakeholder Group perceptions. The weighted average of response score that is relative importance index (RII) descriptive statistics and the ranking method, the delay factors were ranked in order of their relative importance on the statistically significant results and analysis of patterns among the stakeholder groups managerial.

4.0 Data Analysis

Nvivo 14 software was used to analyse the data Data were collected through 17 semi-structured interviews and analysis of 140 official documents of projects using Thematic content analysis, a qualitative research method. The respondents for the interviews were professionals working on National Highway projects in Himachal Pradesh. All 16 professionals had significant work experience, with over 10 years of experience, except for one who had more than 6 years of experience. The results, shown in the Figure 1, helped in extracting 45 items for further questionnaire development.

Figure 1: Word Tree Map Obtained from Text Search Query



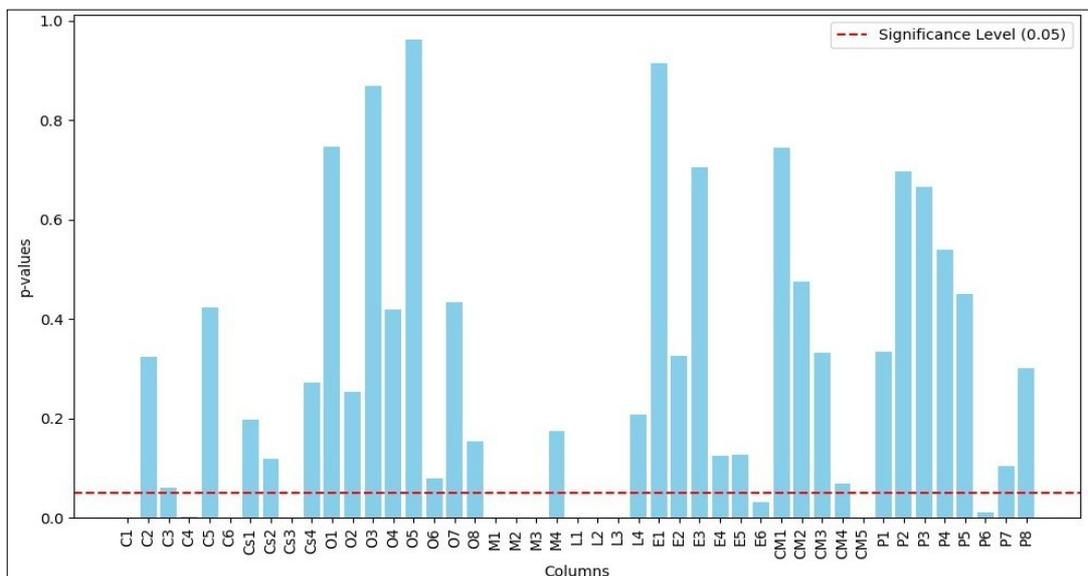
Source: Authors' work

The analysis aimed to investigate the perceptions of owners, contractors, and consultants regarding critical delay factors in highway projects. After conducting the qualitative analysis, the results informed the creation of the questionnaire, which was distributed through mail and personal visits to respondents from three types of organizations: owners, consultants, and contractors. The primary data collected through the questionnaire

yielded a 60.34% response rate, totalling 213 responses: 52 from owners, 87 from contractors, and 70 from consultants. For each 45 items, the Kruskal-Wallis’s test was conducted to compare the perceptions of owners, consultants, and contractors. The test calculated the H-statistic and p-value, indicating evidence against the null hypothesis (i.e., all groups have the same median perception of the delay factor), followed by results of the Kruskal-Wallis test for each column. The null hypothesis is rejected at a significance level of 0.05. A p-value less than 0.05 indicates significant differences in perceptions among the stakeholder groups for that delay factor.

To visualise the results of Kruskal Wallis test, generated visualisations using Python code for the results obtained from performing Kruskal-Wallis tests on all items representing different delay factors in highway projects. The code used the Matplotlib library to create a bar plot displaying the p-values obtained from the tests. All items contain the names of items representing delay factors, namely Contractor-related delay factors (‘C1’, ‘C2’, ‘C3’, ‘C4’, ‘C5’, ‘C6’), Consultant-related delay factors (‘Cs1’, ‘Cs2’, ‘Cs3’, ‘Cs4’), Owner-related delay factors (‘O1’, ‘O2’, ‘O3’, ‘O4’, ‘O5’, ‘O6’, ‘O7’, ‘O8’), Material and Machinery-related delay factors (‘M1’, ‘M2’, ‘M3’, ‘M4’), Labour-related delay factors (‘L1’, ‘L2’, ‘L3’, ‘L4’), External delay factors (‘E1’, ‘E2’, ‘E3’, ‘E4’, ‘E5’, ‘E6’), Contract Management-related delay factors (‘CM1’, ‘CM2’, ‘CM3’, ‘CM4’, ‘CM5’), and Project-specific delay factors (‘P1’, ‘P2’, ‘P3’, ‘P4’, ‘P5’, ‘P6’, ‘P7’, ‘P8’), with each delay factor corresponding to different aspects of the project to be analysed.

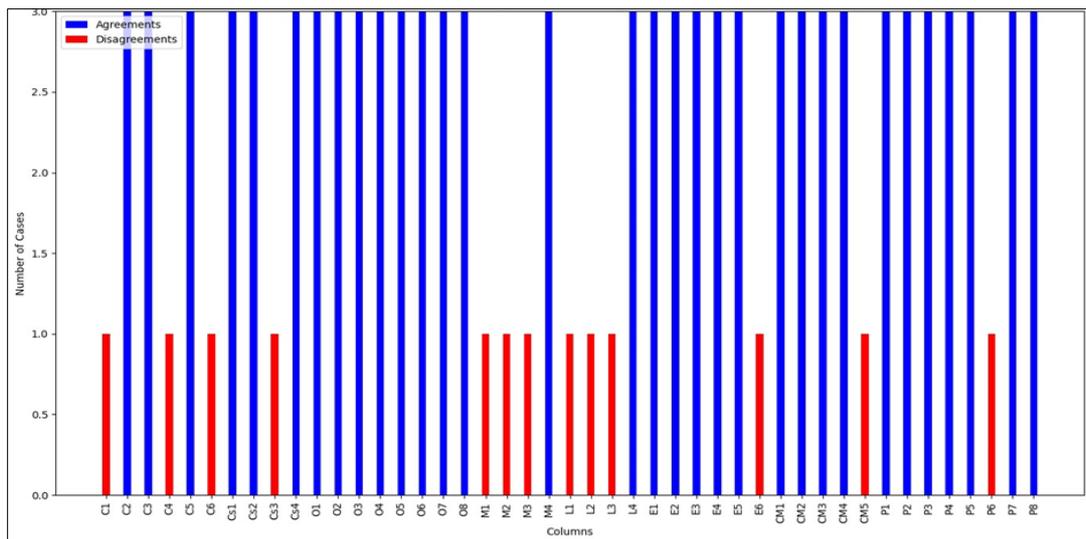
Figure 2 Kruskal-Wallis Test Results



Source: Authors’ work

The 'kruskal' function from the 'scipy.stats' module is then applied to calculate the p-value. The p-values obtained from the tests from each items are appended to 'p_values' list. Finally, a bar plot is generated using Matplotlib, where each bar represents a delay factor column, and the height of the bar corresponds to the p-value obtained from the Kruskal-Walli's test. A horizontal dashed line is added at $y=0.05$, representing the significance level ($\alpha=0.05$). The plot is labelled appropriately with axis labels, a title, and a legend. Additionally, the x-axis labels are rotated vertically for better readability. This visualisation in Figure 2 provides an overview of the statistical significance of differences in perceptions among owners, consultants, and contractors for each delay factor analysed in the study. It helps in identifying which delay factors exhibit significant differences in perceptions among these three groups, aiding project professionals in prioritising mitigation efforts accordingly.

Figure 3 Agree and Disagreements among Roles for Each Variable



Source: Authors' work

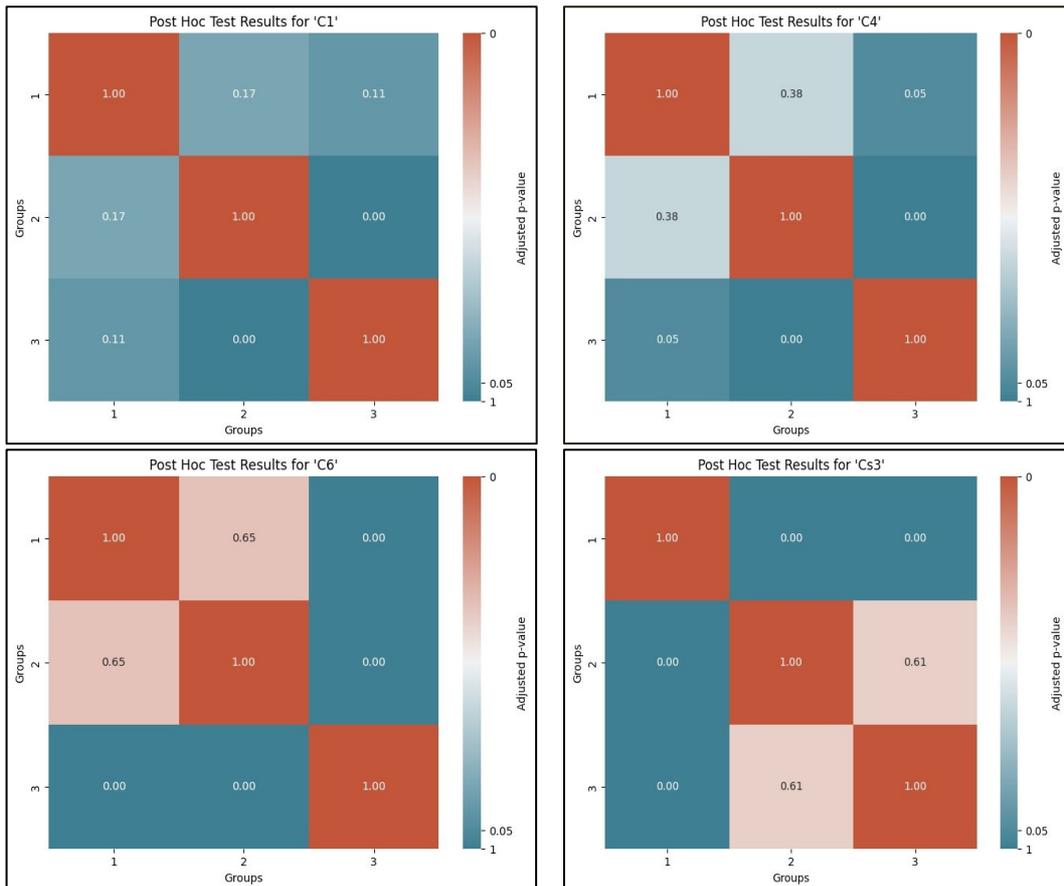
The analysis as shown in Figure 3 indicates a general consensus (overall agreement) among the three project participants regarding delay factors. However, discrepancies in perception were observed for 13 factors. Further examination through post-hoc testing was needed to understand these differences in detail.

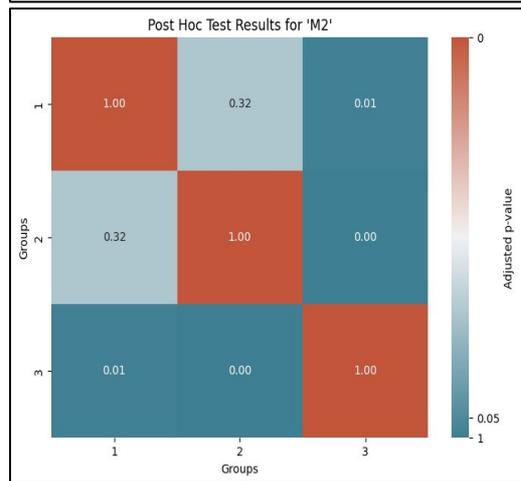
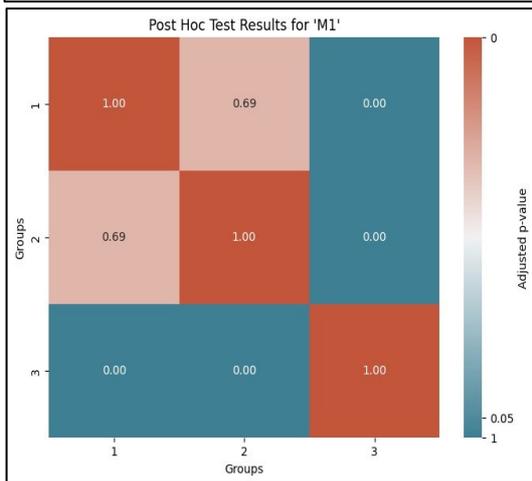
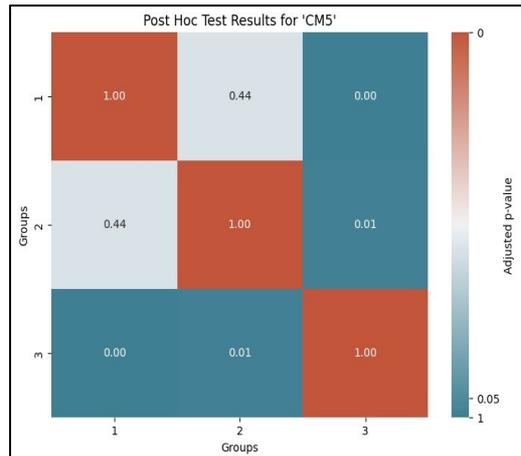
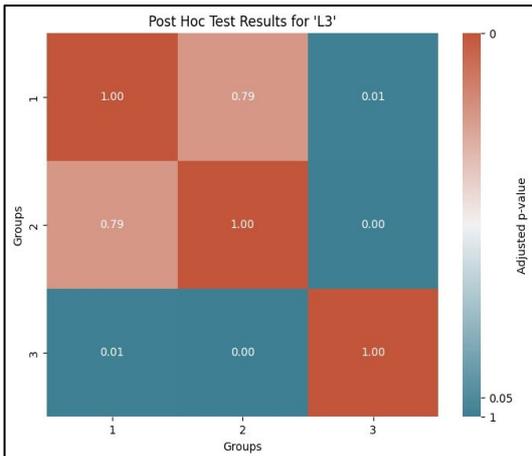
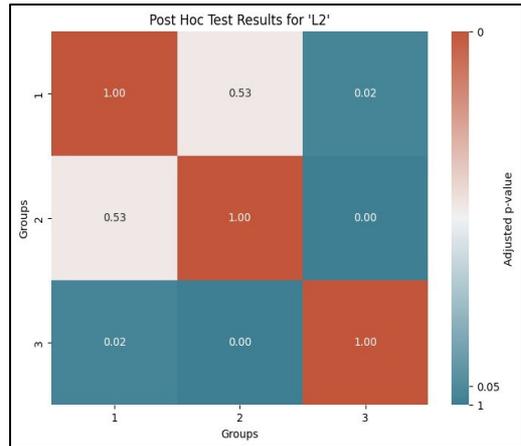
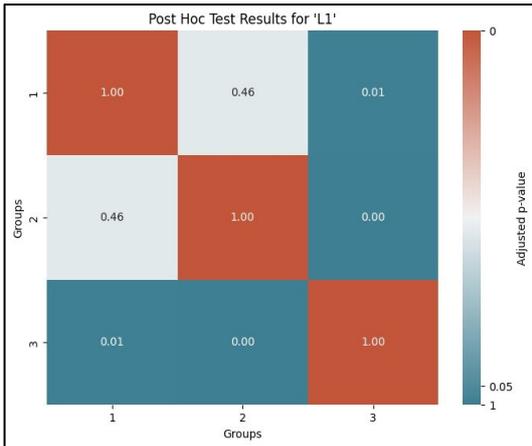
Following the primary analyses of three main stakeholders' perceptions, a post-hoc analysis was conducted to delve deeper into these differences in perception for certain delay factors. Initially, the code in python defined the columns representing delay factors to be

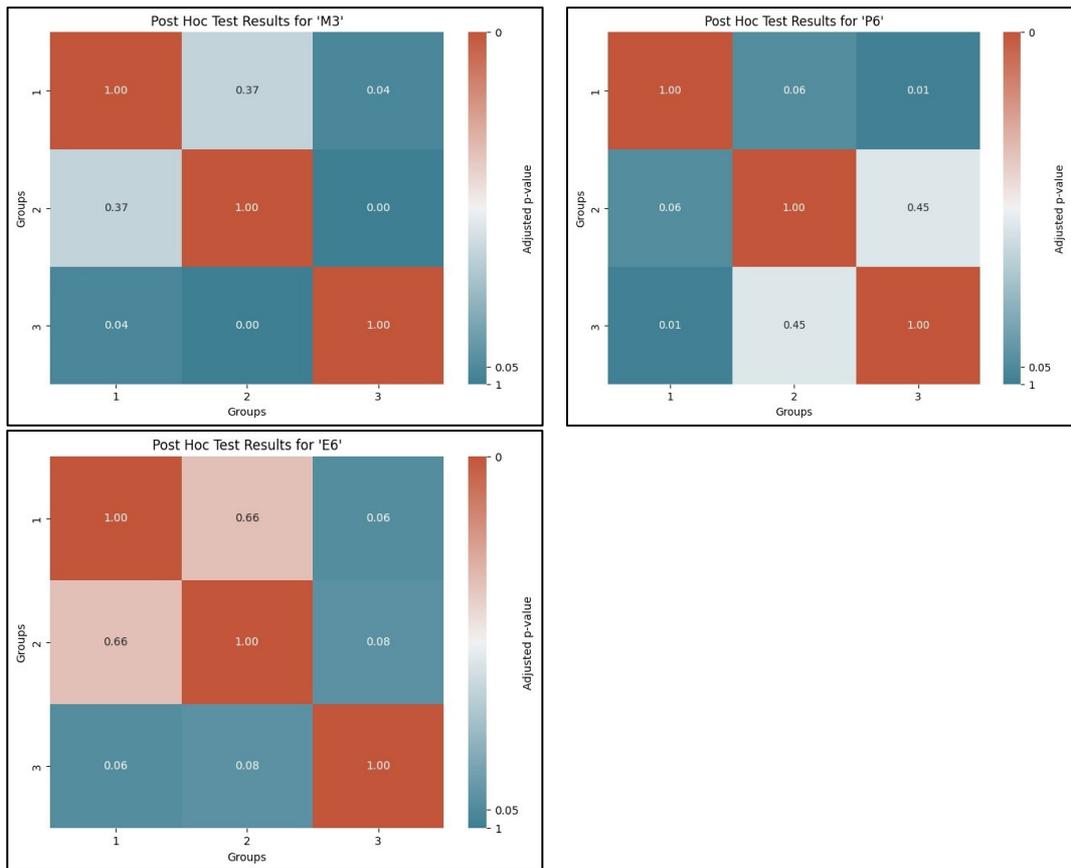
tested for agreement among project participants. Subsequently, *Kruskal-Wallis tests* were performed for each column to assess the statistical significance of differences in perceptions among owners, consultants, and contractors. Columns exhibiting significant differences, as indicated by a p-value below 0.05, were stored in the 'significant_columns' list for further analysis. For each column with significant differences, a post-hoc *Dunn's test* is executed using the *scikit-posthocs* library. This test compares delay factor perceptions between pairs of each group, adjusting for multiple comparisons using the *Holm method*.

The results of the *post-hoc test* was represented visually using a *heatmap*, where different colours represent the adjusted *p-values*. The significance level of the *adjusted p-values* is annotated on the colour bar, helping in interpretation.

Figure 4 Post hoc Test Analysis







Source: Authors' work

This visual representation allows for a comprehensive understanding of how perceptions differ among stakeholder groups for each delay factor, facilitating informed decision-making in project management. Each heat map generated corresponds to a particular delay factor, showing differences in agreement in the Kruskal-Wallis's test. The perception agreement as shown in Figure 4 between any two groups at the 0.05 significance level in the post-hoc analysis are Group 1 (owners), Group 2 (consultants), and Group 3 (contractors).

5.0 Results and Discussion

The interpretation of the results from the analysis reveals several important insights regarding perceptions among project participants regarding delay factors in National Highway projects in Himachal Pradesh:

1. *Overall Agreement among project participants:* Despite differences in perceptions for some factors, the overall agreement ratio among owners, consultants, and contractors exceeds the threshold of 0.75, indicating a high level of consensus regarding the factors influencing delays in the project. This alignment in perceptions can facilitate cohesive decision-making and the development of effective project management strategies. However, the analysis also indicates significant differences in perceptions among owner, consultant, and contractor groups for a few specific delay factors. While the majority of factors exhibit general consensus (with an agreement ratio of 0.88) among owners, consultants, and contractors towards the causes of delay in National Highway projects in Himachal Pradesh.
2. For delay factors ‘C2’, ‘C3’, ‘C5’, ‘Cs1’, ‘Cs2’, ‘Cs4’, ‘O1’, ‘O2’, ‘O3’, ‘O4’, ‘O5’, ‘O6’, ‘O7’, ‘O8’, ‘M4’, ‘L4’, ‘E1’, ‘E2’, ‘E3’, ‘E4’, ‘E5’, ‘CM1’, ‘CM2’, ‘CM3’, ‘CM4’, ‘P1’, ‘P2’, ‘P3’, ‘P4’, ‘P5’, ‘P6’, ‘P7’, and ‘P8’, no significant differences in perceptions were found among stakeholders. This indicates a consensus among owners, consultants, and contractors regarding the significant contribution of these factors to project delays.
3. *Differences in perceptions:* Although certain delay factors did not reach significance levels, their p-values were less than the threshold. These findings suggest potential tendencies towards differences in perceptions among project participants for these factors, emphasising the need for further investigation. The analysis of perceptions among project participants regarding delay factors in National Highway projects in Himachal Pradesh reveals significant insights of factors that on which project participants are in agreement and disagreement, shedding light on critical factors influencing project delays and potential implications for project execution. The study identified several delay factors where perceptions differed among owners, consultants, and contractors, prompting further investigation to understand these differences and their implications.
 - Among the contractor-related factors, “Poor Planning and Scheduling” (C1) stands out as a point of contention, with significant disagreement between consultants and contractors. This suggests potential misalignment between contractors’ scheduling practices and consultants’ expectations, posing a risk of delays due to inadequate planning. Similarly, “Lack of Experience and Incompetent Technical Staff” (C4) and “Poor Site Management and Supervision” (C6) reveal disagreements between consultants and contractors, indicating potential discrepancies in contractors’ technical capabilities and site management practices that could impact project efficiency and timelines.
 - In the realm of consultant-related factors, “Design Error and Lack of Design Information” (Cs2) showcases significant differences between consultants and owners/contractors. This implies potential discrepancies in consultants’ design-

- related decisions or information that may not align with the expectations of other project participants while execution, leading to delays in project execution.
- Regarding material and machinery-related factors, differences among participants are observed in “Equipment Availability and Failure” (M1), “Resource Mobilisation by Contractor” (M2), and “Damaged, Inappropriate, or Poor-Quality Material” (M3). These differences suggest potential problems with contractors’ management of equipment availability, resource mobilisation strategies, and material quality standards that leads to rework to address them, which could contribute to delays in project progress.
 - Labour-related factors, such as “Shortage of Manpower” (L1), “Low Productivity of Labour” (L2), and “Insufficient Deployment of Labour” (L3), highlight disagreements between owners/consultants and contractors, indicating potential shortcomings in contractors’ management of labour resources and deployment practices that may impact project efficiency and timelines.
 - In the realm of contract management, “Disputes Between various Project Parties” (CM5) reveal significant differences between owners/consultants and contractors, suggesting potential issues in owners’ management of contractual disputes that could lead to project disruptions.
 - The project-specific factor “Interruption Due to Traffic” (P6) shows significant discrepancies between owners/consultants and contractors, indicating potential issues that contractors’ face due to traffic-related interruptions or insufficient support from local administration or owner, which could affect project timelines.
4. Unrealistic contract duration imposed by client (‘CM2’), Inadequate supervision, inspection and testing procedure (‘O6’), and Contractors’ financial difficulties (‘C3’), the obtained p-values are 0.0691, 0.0795, and 0.0608, respectively. These p-values are close to the conventional significance level of 0.05 but do not reach it. Therefore, the null hypothesis cannot be rejected at the 0.05 significance level. However, if a less stringent significance level, such as 0.1, were considered, these results would be closer to rejection. This suggests that there may be tendencies towards differences in perceptions among project participants for the corresponding delay factors. Project participants may hold slightly differing views or interpretations regarding these delay factors, which could potentially impact decision-making and project management strategies.
 5. The test conducted on the delay factor “Landslides” (E6) yielded a significant difference, rejecting the null hypothesis that all groups have the same perception regarding this factor. However, the subsequent post hoc tests (see Figure 4) indicating no significant disagreement between any pair of groups—owner and consultant, owner and contractor, and consultant and contractor—regarding their perceptions of E6. This apparent contradiction suggests that while there may be overall differences in perceptions among

project participants regarding landslides, these differences are not significant at the individual pairwise level.

6.0 Conclusion

The perceptions of project participants (including owners, consultants, and contractors) regarding various identified delay factors impacting duration of project execution were studied. The analysis uncovered interesting insights into how project participants perceive delay factors. Although there is a consensus on the majority of factors contributing to delays, significant discrepancies emerged for certain ones. Specifically, factors like poor planning, inadequate supervision, and resource mobilization displayed notable differences in perception among owners, consultants, and contractors. This highlights the importance of promoting mutual understanding and collaboration among stakeholders to address potential conflicts and enhance project efficiency.

Overall, there is broad agreement among owners, consultants, and contractors regarding the causes of delays. The synthesis from analysis highlights the important role of effective project management in navigating the complex landscape of highway construction projects in hilly region. By recognising and addressing disparities in perceptions among project participants, concerned organisations can foster a culture of collaboration and consensus-building essential for project success. Furthermore, the analysis highlights the criticality of strategic decision-making informed by empirical evidence and data-driven insights. With a thorough understanding of the factors affecting project delays, project participants can opt for specific interventions and allocate resources strategically to maximise project performance and improve overall project results.

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References

Abdul-Rahman, H., Takim, R. & Min, W. S. (2009). Financial-related causes contributing to project delays. *Journal of Retail and Leisure Property*, 8(3), 225–238. Retrieved from <https://doi.org/10.1057/RLP.2009.11/TABLES/11>

Akinsiku, O. E. & Akinsulire, A. (2012). Stakeholders' perception of the causes and effects of construction delays on project delivery. *Journal of Construction Engineering and Project Management*, 2(4), 25–31. Retrieved from <https://doi.org/10.6106/JCEPM.2012.2.4.025>

Akomah, B. B. & Jackson, E. N. (2016). Contractors' perception of factors contributing to road project delay. *International Journal of Construction Engineering and Management*, 5(3), 79–85. Retrieved from <https://doi.org/10.5923/J.IJCEM.20160503.02>

Al Saeedi, A. S. & Karim, A. M. (2022). Major factors of delay in developing countries construction projects: Critical review. *International Journal of Academic Research in Business and Social Sciences*, 12(5). Retrieved from <https://doi.org/10.6007/IJARBS/V12-15/13309>

Allsop, D. B., Chelladurai, J. M., Kimball, E. R., Marks, L. D. & Hendricks, J. J. (2022). Qualitative methods with Nvivo software: A practical guide for analyzing qualitative data. *Psych 2022*, 4(2), 142–159. Retrieved from <https://doi.org/10.3390/PSYCH4020013>

Ametepey, S. O., Aigbavboa, C. O. & Thwala, W. D. (2023). Stakeholder management in sustainable road infrastructure development. *Sustainable Road Infrastructure Project Implementation in Developing Countries: An Integrated Model*, 113–118. Retrieved from <https://doi.org/10.1108/978-1-83753-810-220231010>

Artino Jr, A. R., La Rochelle, J. S., Dezee, K. J., Gehlbach, H. & Artino, A. R. (2014). Developing questionnaires for educational research: AMEE Guide No. *Medical Teacher*, 37(6), 463–474. Retrieved from <https://doi.org/10.3109/0142159X.2014.889814>

Çevikbaş, M. & Işık, Z. (2021). An overarching review on delay analyses in construction projects. *Buildings*, 11(3), 109. Retrieved from <https://doi.org/10.3390/BUILDINGS11030109>

Creswell, J. W. (2009). Research design qualitative quantitative and mixed methods approaches. In *Research Design* (3rd Editio, Vol. 4, Issue June). Sage publication.

Esperilla-Niño-de-Guzmán, Y. Y., Baeza-Muñoz, M. de los Á., Gálvez-Sánchez, F. J. & Molina-Moreno, V. (2024). Public–Private Partnership (PPP) in road infrastructure projects: A review of evolution, approaches and prospects. *Sustainability*, 16(4), 1430. Retrieved from <https://doi.org/10.3390/SU16041430>

James T. M. & George Benson, T. T. S. (2021). Statistics for business and economics. Pearson. Retrieved from <https://www.pearson.com/store/en-us/pearsonplus/p/9780137335428.html>

Karunakaran, S., Ramli, M. Z., Malek, M. A., Musir, A. A., Imran, N. F., Fuad, N. F. S. M., Zawawi, M. H. & Zainal, M. Z. (2018). Causes of delay on highway construction project in Klang valley. *AIP Conference Proceedings*, 2030. Retrieved from <https://doi.org/10.1063/1.5066883>

Khahro, S. H., Shaikh, H. H., Zainun, N. Y., Sultan, B., Khahro, Q. H., Hussain Khahro, S., Shaikh, H. H., Zainun, N. Y., Sultan, B. & Khahro, Q. H. (2023). Delay in decision-making affecting construction projects: A sustainable decision-making model for mega projects. *Sustainability*, 15(7), 5872. Retrieved from <https://doi.org/10.3390/SU15075872>

Kruskal, W. H. & Wallis, W. A. (1952). Use of ranks in one-criterion variance analysis. *Journal of the American Statistical Association*, 47(260), 583–621. Retrieved from <https://doi.org/10.1080/01621459.1952.10483441>

Kumar, M. & Kumari, S. (2022). Cost performance of Public, Private, Partnership (PPP) road projects in India. In *NICMAR-Journal of Construction Management*, 37(3), 13–22.

Kumar, M. & Kumari, S. (2023). Empirical study on delays in highway projects: A comparative analysis of small & large projects. *National Conference on Contemporary Trends in Business, Management & Management & Entrepreneurships, (NCCTBME - 2023), Himachal Pradesh University Business School, Summerhill, Shimla-05*.

Kumar, M. & Kumari, S. (2025). Causes of delays in road construction projects: A systematic review. *Journal of Financial Management of Property and Construction*, 30(2), 256–294. Retrieved from <https://doi.org/10.1108/JFMPC-01-2023-0004>

Mejía, G., Sánchez, O., Castañeda, K. & Pellicer, E. (2023). Stakeholders' issues as a source of project delays: a meta-analysis between building and road projects. *Revista de La Construcción. Journal of Construction*, 22(1), 51–73. Retrieved from <https://doi.org/10.7764/RDLC.22.1.51>

Milind Mehta, S., Chang, S., Oh, H. J., Kwon, J. H. & Kim, S. (2022). An investigation of construction project efficiency: Perception gaps and the interrelationships of critical factors. *Buildings*, 12(10), 1559. Retrieved from <https://doi.org/10.3390/BUILDINGS12101559>

Nyandika, O. O. & Ngugi, K. (2014). Influence of stakeholders' participation on performance of road projects at Kenya National Highways Authority. *European Journal of Business Management*, 1(11), 384–404. Retrieved from <http://www.ejobm.org>

Rivera, L., Baguec, H. & Yeom, C. (2020). A study on causes of delay in road construction projects across 25 developing countries. *Infrastructures*, 5(10), 84. Retrieved from <https://doi.org/10.3390/INFRASTRUCTURES5100084>

Rivera, L. & Baguec Jr, H. (2020). Delays in highway construction projects: A qualitative study on hilly road projects. *Infrastructures*, 5(10), 84. Retrieved from <https://doi.org/10.5281/ZENODO.10552759>

Sanni-Anibire, M. O., Mohamad Zin, R. & Olatunji, S. O. (2020). Causes of delay in the global construction industry: A meta analytical review. *International Journal of Construction Management*. Retrieved from <https://doi.org/10.1080/15623599.2020.1716132>

Scipy.stats.kruskal - SciPy v1.13.1 Manual. (n.d.). Retrieved from <https://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.kruskal.html>

Shaban, S. A., Elkourd, R. & Saif, M. A. (2024). Causes of delay in construction industry: Perception of consultants in Palestine. Retrieved from https://doi.org/10.1007/978-3-031-49544-1_30

Shahsavand, P., Marefat, A. & Parchamijalal, M. (2018). Causes of delays in construction industry and comparative delay analysis techniques with SCL protocol. *Engineering, Construction and Architectural Management*, 25(4), 497–533. Retrieved from <https://doi.org/10.1108/ECAM-10-2016-0220/FULL/PDF>

Sharma, V. K., Gupta, P. K. & Khitoliya, R. K. (2021). Analysis of highway construction project time overruns using survey approach. *Arabian Journal for Science and Engineering*, 46(5), 4353–4367. Retrieved from <https://doi.org/10.1007/S13369-020-04934-4/TABLES/9>

Shukla, B. K., Bansal, V., Varadharajan, S., Bharti, G., Shenoy, A., Singh, U. K. & Kirthanashri, S. V. (2023). Identification and analysis of factors of delay in road construction projects. *Lecture Notes in Civil Engineering*, 280, 505–511. Retrieved from https://doi.org/10.1007/978-981-19-4739-1_47

Vohra, N. (2019). *Business statistics: Text and problems - with introduction to business analytics*. McGraw-Hill. Retrieved from <https://doi.org/10.4324/9781315501932-17>

Yang, Y., Wei, Z. & Zhang, Z. (2023). Stakeholder relationship in construction projects: A mixed methods review. *Buildings*, 13(12), 3122. Retrieved from <https://doi.org/10.3390/BUILDINGS13123122>