Asian And Pacific Economic Review
ISSN: 1000-6052

EFFECTIVE MANAGEMENT OF EXTENSION OF TIME (EOT) CLAIMS IN INFRASTRUCTURE PROJECTS

Dr.B.Ravinder[1],

[1]Associate Professor, NICMAR University of Construction Studies, Hyderabad, Telangana, India

Gurram Govardhan Raja[2], N. Vinay Kumar[2], N. Venkata Sai Athreya[2]

[2] PGD QSCM (2024- 2025), NICMAR University of Construction Studies Hyderabad, Telangana, India

https://doie.org/10.65985/APER.2026756112

ABSTRACT

Infrastructure built and developed by the government in the interest of public facility. The project/s cannot be built overnight without having contracting system in place and its presence across the globe is appreciated. Government used to develop the projects through various types of contracts based on the available resources. There is shift in type of contract executed over a period of time based on available resources. The National Highways Authority of India (NHAI) is the primary agency responsible for the development, maintenance, and management of the National Highway network in India. It implements highway construction projects (including expressways) under various government programmes and adopts a financing models such as EPC, HAM, and BOT. This study investigates the effectiveness of claim management in HAM-based highway projects by identifying major delay-causing factors and evaluating their legitimacy from the perspective of key stakeholders. The research combines structured surveys with a statistical tool such as ANOVA to assess the severity and perception of delays across consultants, contractors, and employers.

Considering the significant levels, the order of factors impacting the extension of time is Delay in approval of change in scope, Land Acquisition, Delay in Design Approvals, Pre-Construction activities, Construction Execution Material Procurement Work Force Issues, Delay in commencement of ATMS work and Weather Conditions. Differences in stakeholder perceptions reveal the need for standardized procedures in claim evaluation and stronger contractual clarity. This study contributes practical insights and recommendations to improve the administration of EOT claims and foster collaborative claim management practices in public-private infrastructure projects, ensuring improved risk mitigation and timely project delivery.

Keywords: Contract, Risk, HAM, Delay Analysis

INTRODUCTION

NHAI is the primary agency responsible for developing, maintaining, and managing National Highways, which carry 40% of road traffic and 60% of freight movement, even though they form only about 2% of total road length in India. Well-developed highways to reduce transportation costs, improve supply chains, support industrial corridors and MSMEs. NHAI highways connect markets, ports, industrial zones, and cities, directly contributing to GDP growth in India. NHAI plays a key role in developing the Bharatmala Pariyojana, Make in India, Gati Shakti, Logistics Efficiency Enhancement and these programs depend heavily on strong highway infrastructure. The national highway length increased by 60% over a period of 10 years (i.e. 2014–2024). The construction industry faces its most significant test through the

challenge of delivering infrastructure projects such as highways on schedule. The government planning and private sector execution must continuously adjust to the uncontrolled situations that occur during implementation in India under the Engineering, Procurement and Construction (EPC) model, Public-Private Partnership (PPP) model, Hybrid Annuity Model (HAM). A claim is a formal request for compensation or adjustment due to a deviation from the agreed contract terms. Claims are inevitable if not properly managed. Poor claim management can lead to project overruns, financial losses, and disputes. Infrastructure projects are complex, high-value, and long-term, often involving: multiple stakeholders (government agencies, contractors, consultants, financiers), dynamic environmental and site conditions, technical and design uncertainties, regulatory changes or approvals delays. The combination of land acquisition challenges with design approval delay and environmental clearance problems, as well as extreme weather conditions and schedule disruptions. Contractors with concessionaires turn to Extension of Time (EOT) provisions as their method to prevent penalties while maintaining project momentum. The situation becomes complicated when dealing with time extension claims and their associated compensation matters. The requirements for identifying a legitimate delay alongside proper documentation methods and diverse stakeholder perspectives create ongoing confusion between consultants and contractors& government bodies. The lack of understanding regarding delay qualification procedures creates situations that result in project stoppages and conflicts between stakeholders. A contract, as defined under the Indian Contract Act, 1872, is a legally binding agreement between two or more parties that outlines the scope, terms, and conditions under which a project will be executed. It specifies the obligations, deliverables, timelines, and compensation for all parties involved, ensuring adherence to mutually agreed-upon responsibilities. Highway infrastructure projects in India are executed through a variety of contract models, shall be classified into traditional contracts and non-traditional contracts (Fig.1). Traditional contracting models shall be of government-funded and designed projects. Non-traditional contracting models involve collaboration between the government and private entities for designing, financing, construction, and maintenance. The choice of contract type depends on factors such as project size, risk allocation, funding availability, and desired operational control. Design-bid-build, lump sum, cost plus contracts are categorized under the traditional contracts. Engineering, Procurement, and Construction (EPC), Public-Private Partnership (PPP) Models and there are various models and couple of them are Build-Operate-Transfer (BOT), Build-Own-Operate-Transfer (BOOT), Design-Build-Finance-Operate-Transfer (DBFOT), Hybrid Annuity Model (HAM). The exclusiveness of HAM is that the government pays 40% of the project cost during construction, while the remaining 60% is paid over time as annuity payments. The private party does not have toll rights; revenue comes from the government.

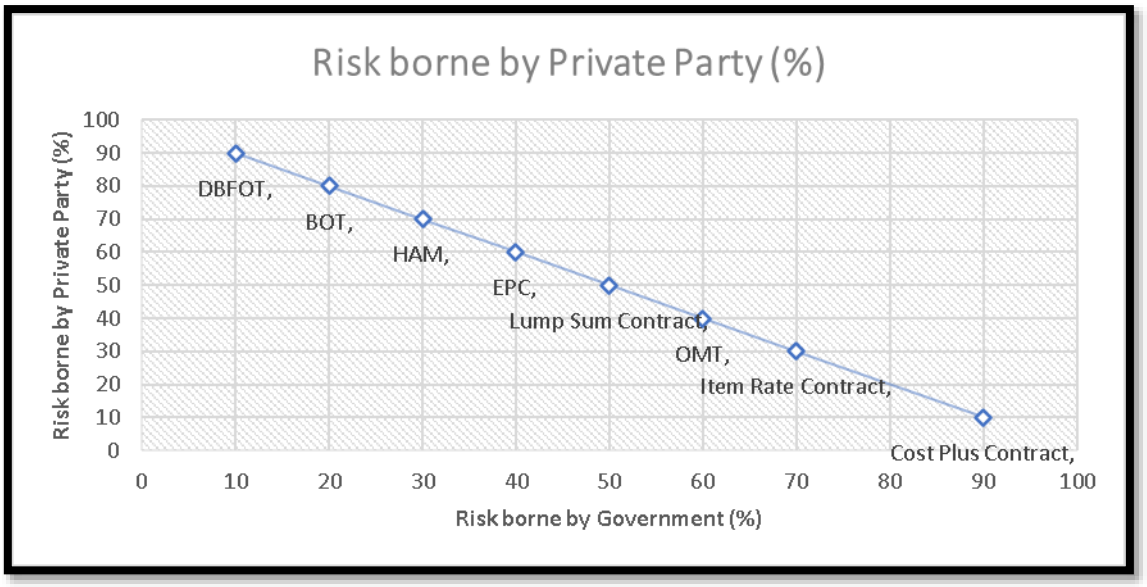

Fig.2: Contracting methods based on risks sharing among contracting entities

Purpose of the Claim Management in Infrastructure Projects: The purpose of claim management study in infrastructure is to understand and capture the financial protection, time management, dispute minimization, documentation & record keeping, project continuity, contract compliance, improves stakeholder confidence.

Objectives

The objective of this study is to systematically investigate the management of claims in Hybrid Annuity Model (HAM) infrastructure projects to understand their causes, types, impacts, and resolution mechanisms. The objectives of the study is:

1. To identify and categorize claims that commonly arise in HAM projects, such as delays, cost escalations, variations, and unforeseen site conditions.
2. To analyze the root causes and consequences of claims on project performance, including time, cost, and quality.
3. To evaluate existing claim management practices adopted by contractors, consultants, and project authorities.
4. To develop effective strategies and recommendations for minimizing disputes, resolving claims efficiently, and enhancing project outcomes.

Scope

The scope of this study defines the boundaries and extent of research on the management of claims in Hybrid Annuity Model (HAM) infrastructure projects. The study focuses on the type of Projects (The research is limited to infrastructure projects executed under the HAM model, such as highways, bridges, and expressways), types of Claims (It will focus on common contractual claims, including delay claims, cost escalation claims, scope variation claims, unforeseen site conditions, and claims related to contractual disputes), Stakeholders (The study considers the perspectives of key stakeholders, including contractors, consultants, project authorities, and government agencies involved in claim management), Processes and Practices (It covers the identification, documentation, evaluation, and settlement of claims, as well as strategies for prevention and mitigation of disputes), Geographical and Temporal Scope (The research is primarily limited to projects within a defined region or country (depending on your

data availability) and focuses on projects completed or under execution in recent years), Objectives of Analysis (The study aims to analyze causes and impacts of claims, evaluate current management practices, and propose recommendations for improving claim handling in HAM projects).

Literature Review

A literature review is a structured summary and critical analysis of existing books, articles, reports, and other credible sources related to a specific topic. It helps identify key findings, patterns, gaps, and differing perspectives in current knowledge. In this project, the literature review was used specifically as secondary data, providing background information and established insights on various construction contract models, including both traditional and non-traditional approaches. By analyzing existing research, it supported a deeper understanding of how these contracts are applied in practice, their associated risks, responsibilities, and financial structures. This helped ground the project in credible, existing knowledge and guided the study's direction.

Jain et al. (2019) present an important study that identifies prominent issues in PPP and HAM models based on stakeholder questionnaires. Delays in traffic studies and feasibility reports, environmental impact assessments (EIA), and monitoring projects are major concerns identified. Delayed government funding and lack of transparency have been identified as the most important causes of delays in PPPs, while HAM projects are hampered by funding issues, which usually cause a 20% delay in the total project duration. Financial risk was found to be the most critical threat in both models. These results emphasize the requirement for better risk allocation, timely funding, and transparent project governance through alternative models to improve efficiency.

In order to determine the delay factors influencing Hybrid Annuity Model (HAM) highway projects in India, Rathore and Trivedi (2021) carried out an extensive survey-based study. Sixty percent of the 3,200-kilometer HAM projects were finished on time, but the rest had major delays. Under the headings of land acquisition, stakeholder coordination, resource idling, schedule extensions, and environmental clearances, the study found 35 significant delay reasons. 384 professionals, including clients, contractors, and consultants, responded, highlighting typical problems such as design setbacks, political intervention, significant delays in monitoring. These revelations aid in comprehending systemic inefficiencies and developing plans for better HAM-based infrastructure project execution.

Enegbuma, Wallace Imoudu, et al. (2023) Investigated delay factors using the DEMATEL method and published their findings identifying incomplete documentation as the primary cause. The study concluded that mapping cause-effect relationships helps project managers in reducing delays and disputes.

Senić, A., Dobrodolac, M., & Stojadinović, Z have published a study using Sugeno Fuzzy Logic to predict EoT and cost increases. They investigated 28 Serbian road projects and concluded that fuzzy modeling can improve early risk assessment and strategic decision-making in project planning.

Ghosh and Karmakar (2023) have investigated delay-related claims in Indian highway projects and published results highlighting categories such as execution and administrative issues. They concluded that planning, contract clarity, and digital claim systems are essential to improve outcomes.

Jain, F., Khan, et al. (2019) published a comparative study where they investigated two highway project models. By surveying key stakeholders, they identified real-world risks and delay factors and concluded that stakeholder involvement and model selection significantly impact project success.

Kumar, Modish and Kumari, Santosh (2024) published a comparative study identifying delay factors in highway projects in India's mountainous regions. The study highlighted government-related issues (e.g., land and utility delays) and contractor-related the main causes through literature review and industry professionals' survey. Significant causes of cost overruns are price hikes of construction materials, land acquisition and resettlement, inadequate planning, wrong government policies, extra work, and inefficient contractor cost control. Delays are triggered primarily by late progress payments, contractor inability, poor planning, late site handover, and land acquisition delays. The research underscores the dominance of client causes and emphasizes the imperative of enhanced project management and policy reforms in curbing delays and cost overruns.

O'Connor, J. T., Chmaytelli, A., & Hugo, F. (1993) published a research analyzing 71 highway contract claims submitted between 1982–1987. They identified underlying causes such as poor risk management and planning, and concluded that preventive strategies can reduce future claims and costs.

Okereke, Reuben A., Mohammed, Zakariyau, et al. (2021) published a study investigating challenges in managing Extension of Time (EOT) claims in large construction projects. By surveying professionals in Nigeria, they identified critical elements needed to substantiate EOT claims and concluded that a structured claim process is essential for timely resolution.

Osman, Ibrahim and Ataei, Hossein (2021) Explored and published the impact of the COVID-19 pandemic on construction projects, identifying legal and operational uncertainties. They concluded that future contracts must address pandemic-like disruptions more clearly to avoid disputes.

Parikh, Dhaval, Joshi, G. J., et al. (2019) conducted an analysis of 573 disputes across 77 highway construction contracts in India. They identified root causes of contractor client conflicts and concluded that better dispute management and planning strategies are crucial for future projects.

Rathore, Avinash and Trivedi, Manoj Kumar (2021) conducted and published a survey-based study to identify delay causes in HAM model highway projects. They concluded that while 60% of HAM projects were completed on time, delays in the remaining projects were mainly due to issues such as land acquisition, funding problems, and contractor inefficiencies.

Taneja, Anmol and Kalra, Dr. Rosy (2019) published a study highlighting how funding challenges and toll-related risks led to road project delays in India. They concluded that the introduction of the Hybrid Annuity Model addressed these risks and supported better financial structuring for projects.

Vajdica, Nevena, Mladenovicb, Goran, et al. (2022) published a financial assessment study on infrastructure concessions. They identified revenue sources for private partners and concluded that toll collections and government support via availability payments are essential for project sustainability.

Modish Kumar and Santosh Kumari (2024). "Empirical Study on Delays in Highway Projects: A Comparative Analysis of Small and Large Projects" looks at delay factors influencing Indian highway projects, especially in mountainous areas like Himachal Pradesh. It pointed internal as well as outside reasons for delay. From the government's perspective, problems including land acquisition, utility shifting, forest clearances, and delayed approvals come under focus. From the contractor's standpoint, delays result from inadequate site supervision, financial restrictions, construction mistakes, and poor planning. The research also highlights design-related problems including poor design knowledge, erroneous polls, and coordination breakdowns. Timeliness of execution is further complicated by natural conditions including heavy rains, snowfall, floods, landslides, and force majeure events. The studies stress that delays arise from Several overlapping elements imply that more effective and timely delivery of highway infrastructure projects depend mostly on better coordination, planning, and stakeholder communication.

Mohamad Ibrahim Mohamad, Ismail Saad, Nurmin Bolong, J. Mustazama, Siti Nooraiin Mohd Razali in their study "Case Study of S-Curve Analysis" investigated how S-curve models can be used to track, monitor, and assess delays in a private construction project located in Sabah, Malaysia. The S-curve was used as a baseline to evaluate deviations and support Extension of Time (EoT) by contrasting planned and actual progress. 16 delay factors were found in the study, including weather delays, poor planning, slow decision-making, a lack of personnel, and disparities in drawings. EoT applications are strengthened when supported by comprehensive records, according to stakeholder interviews and project documentation. The example demonstrates how useful S-curve analysis is for anticipating delays and making sure on time project delivery.

Norazian Mohamad Yusuwana, Hamimah Adnanba, faculty of Architecture Planning and Surveying 2024. Construction delays in Malaysia are frequently caused by poor management, equipment malfunctions, labour shortages, and force majeure events, according to the study "Issues Associated with Extension of Time (EOT) Claim in Malaysian Construction Industry". Even though EOT clauses are included in standard contracts, disagreements usually arise from unclear delay classification, especially when it comes to concurrent and excused delays. Common issues include disagreements regarding eligibility, lack of documentation, and noncompliance with notification requirements. Conflicts are exacerbated when there are unclear provisions for concurrent delays. Although the study suggests improved documentation practices and more precise contractual definitions to reduce EOT-related disputes and improve project outcomes, negotiation is still the recommended method of resolution.
Wallace Imoudu Enegbuma, Jibril Adewale Bamgbade, Chukwuka Christian, Nahiyan Al-Azad1, the study "Influencing Factors in Extension of Time Claims" investigated the main reasons why construction projects in Malaysia experience delays that result in EOT. The study, which employs a quantitative methodology and the DEMATEL method, finds that incomplete documents are the most significant contributing factor, setting off a series of associated delays such as budgetary limitations, a lack of personnel, and subpar work. The study, which surveyed 80 professionals in the industry, helps project managers prioritize strategic interventions by classifying delay factors into causes and effects. Better monitoring and proactive planning are made possible by mapping causal relationships, which eventually lowers.

Bittu Ghosh and Somnath Karmakar's 2024 study explored the underlying reasons for claims in Indian highway construction projects, highlighting how they affect schedule and cost overruns. The research uses a structured quantitative approach, gathers industry practitioners'

insights, and uses a case study to validate findings. Using the fishbone model, claims were divided into four categories: contractual, technical, project management, and external factors. The main causes were found to be scope changes, design flaws, land acquisition problems, and regulatory delays. The study emphasizes that in order to minimize conflicts and guarantee more seamless project delivery in the highway industry, efficient planning, unambiguous contracts, and proactive communication are crucial.

In order to assist practitioners in anticipating and reducing disputes, the study by Marwa Ahmed et al. (2022) explored the underlying causes of claims in building construction projects in Egypt. Claim causes were divided into operational, contractual, and behavioral factors after a review of the literature and expert validation. The Relative Importance Index (RII) was used to rank the top causes after analysis using SPSS and Excel. Change orders, late payments, the owner's sluggish decisions, design flaws, inflation, and ambiguous contract documents were the main causes of claims. The study highlights that lowering construction-related claims requires improved communication, precise specifications, prompt decisions, and a clear contract scope.

Pornsirichotirat et al.'s 2022 study on highway construction delays in Thailand identifies the main factors influencing project timelines. The study identified eight primary causes of delays using questionnaires and expert interviews. The most common ones are incomplete drawings, contractor financial/equipment inefficiencies, delays in relocating utilities, inexperienced project engineers, and environmental assessment delays. Both project owners and contractors are greatly impacted by these delays. Localized problems, such as safety concerns and regulatory holdups, differ from global delay patterns, according to the study, which evaluates severity and frequency using a mean square analysis. To reduce delays, it is advised to strengthen contractor evaluations, expedite clearances, and improve documentation.

Norazian Mohamad Yusuwana, Hamimah Adnanba, faculty of Architecture Planning and Surveying 2024, Construction delays in Malaysia are frequently caused by poor management, equipment malfunctions, labour shortages, and force majeure events, according to the study "Issues Associated with Extension of Time (EOT) Claim in Malaysian Construction Industry". Even though EOT clauses are included in standard contracts, disagreements usually arise from unclear delay classification, especially when it comes to concurrent and excused delays. Common issues include disagreements regarding eligibility, lack of documentation, and noncompliance with notification requirements. Conflicts are exacerbated when there are unclear provisions for concurrent delays. Although the study suggests improved documentation practices and more precise contractual definitions to reduce EOT-related disputes and improve project outcomes, negotiation is still the recommended method of resolution.
According to Hosh and Karmakar (2023), claims resulting from delays, scope changes, design modifications, and site possession issues are common in Indian highway construction projects. Stakeholder relationships are strained as a result of these claims, which greatly increase project time and costs. The research divided claim causes into change, delay, environmental, financial, execution, and administrative categories using a quantitative practitioner survey and a validating case study. The most frequent and severe factors are discontinuous site possession, delayed decisions, disparate site conditions, and excessive additional work. To reduce claims and improve project results, the study suggests better planning, explicit contract clauses, and digital claim management systems.

Choudhry, Nasir, and Gabriel (2012) investigated the causes of cost and time overruns in Pakistan’s highway projects through surveys of contractors, consultants, and clients. Major

factors driving cost overruns include scope changes, inappropriate government policies, poor planning, price escalations, and land acquisition delays. For time overruns, delayed progress payments, force majeure events, contractor incapability, financial issues, and land acquisition stand out. The study reveals substantial agreement among stakeholders on these factors, emphasizing the need for improved risk and project management. Their findings guide proactive measures to reduce delays and budget excesses in road infrastructure development.

Nasir, Gabriel, and Choudhry (2025) analyzed cost and time overruns in Pakistan's highway projects, highlighting their impact on the construction industry's contribution to GDP. Using literature review and a questionnaire survey, they identify critical causes such as delays in progress payments, land acquisition, price escalation of materials, poor planning, contractor incapability, and government policy issues. The study emphasizes that these factors substantially affect project duration and costs. The authors advocate for improved project management practices to minimize overruns, ultimately boosting infrastructure development and economic growth in Pakistan.

Methodology

Introduction:

It is a process of exploring why Extension of Time (EOT) clauses are included and applied in India's Hybrid Annuity Model (HAM) highway projects. To get a well-rounded understanding, the study uses a mixed-methods approach, blending in literature reviews with broader survey data. Insights are drawn from interviews with key stakeholders and on-site observations, offering a closer look at real-world practices. Additional information comes from project documents, contracts, and existing research. To identify the main causes of project delays, the study uses some steps as shows in Fig. 2.

Study Area: Indian highway infrastructure projects under the Hybrid Annuity Model (HAM) serve as the main focus of this study. The study concentrates on Extension of Time (EOT) provisions implemented during project delays. The study examines projects which filed Extension of Time claims to determine delay causes and to evaluate how all stakeholders such as concessionaires, consultants and authorities manage such claims. The research aims to evaluate current implementation practices of EOT clauses in reality and identify areas for enhancement.

Secondary data: Secondary data, gathered through literature review, involves analyzing existing studies, reports, and documents to provide context, validate findings, and identify the factors.

Primary data: Primary data collection involves engaging with stakeholders and visiting project sites to gather first-hand insights. This method ensures a practical, real-world understanding of the challenges faced during HAM project execution.

Hypothesis: This study operates by assuming that delays within HAM highway projects result from land acquisition difficulties together with approval delays and utility shifting problems. The research assumes that project delays create substantial problems which lead to financial excesses as well as time extensions and strained stakeholder relations. The research intends to verify the validity of these assumptions by examining the relationship between delay causes and their actual results.

Hypothesis Formulation: By accepting or rejecting these hypotheses based on p-values and statistical significance, the study adds scientific rigor to conclusions about which factors are most influential in causing project delays.

$H1_o$: The respondents indicated that land acquisition is not a significant factor leading to the need for an Extension of Time (EOT) in highway projects.
$H1_a$: The respondents indicated that land acquisition is a significant factor contributing to the need for an Extension of Time (EOT) in highway projects.

$H2_o$: The respondents indicated that environmental clearances are not a significant factor contributing to the need for an Extension of Time (EOT) in highway projects.
$H2_a$: The respondents indicated that environmental clearances are a significant factor contributing to the need for an Extension of Time (EOT) in highway projects.

$H3_o$: The respondents indicated that delays in design approvals are not a significant factor contributing to the need for an Extension of Time (EOT) in highway projects.
$H3_a$: The respondents indicated that delays in design approvals are a significant factor contributing to the need for an Extension of Time (EOT) in highway projects.

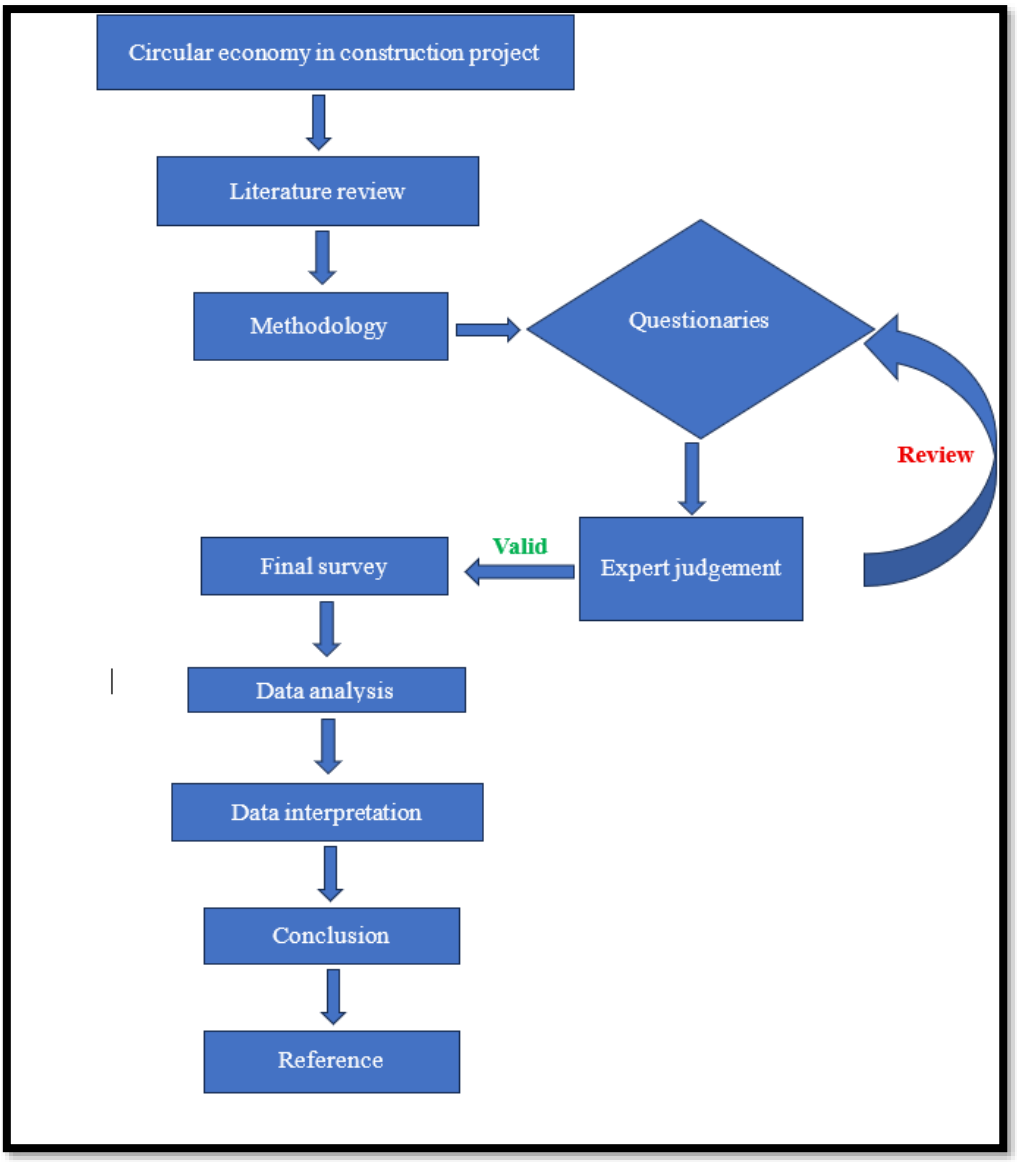

Fig. 2: Methodology Flow Chart

$H4_o$: The respondents indicated that delays in the commencement of ATMS (Advanced Traffic Management System) work are not a significant factor contributing to the need for an Extension of Time (EOT) in highway projects.
$H4_a$: The respondents indicated that delays in the commencement of ATMS (Advanced Traffic Management System) work are a significant factor contributing to the need for an Extension of Time (EOT) in highway projects.

$H5_o$: The respondents indicated that delays in the approval of changes in project scope are not a significant factor contributing to the need for an Extension of Time (EOT).
$H5_a$: The respondents indicated that delays in the approval of changes in project scope are a significant factor contributing to the need for an Extension of Time (EOT).

$H6_o$: The respondents indicated that the occurrence of force majeure events is not a significant factor contributing to the need for an Extension of Time (EOT).

$H6_a$:The respondents indicated that the occurrence of force majeure events is a significant factor contributing to the need for an Extension of Time (EOT).

$H7_o$: The respondents indicated that delays in getting design approval for ROBs/RUBs are not a significant factor contributing to the need for an Extension of Time (EOT).
$H7_a$: The respondents indicated that delays in getting design approval for ROBs/RUBs are a significant factor contributing to the need for an Extension of Time (EOT).
$H8_o$: The respondents indicated that changes in scope are not a significant factor contributing to the need for an Extension of Time (EOT).
$H8_a$: The respondents indicated that changes in scope are a significant factor contributing to the need for an Extension of Time (EOT).
$H9_o$: The respondents indicated that electrical utility shifting is not a significant factor contributing to the need for an Extension of Time (EOT).
$H9_a$: The respondents indicated that electrical utility shifting is a significant factor contributing to the need for an Extension of Time (EOT).
$H10_o$: The respondents indicated that financial constraints are not a significant factor contributing to the need for an Extension of Time (EOT).
$H10_a$: The respondents indicated that financial constraints are a significant factor contributing to the need for an Extension of Time (EOT).
$H11_o$: The respondents indicated that delays in the execution of utility structures are not a significant factor contributing to the need for an Extension of Time (EOT).
$H11_a$: The respondents indicated that delays in the execution of utility structures are a significant factor contributing to the need for an Extension of Time (EOT).
$H12_o$: The respondents indicated that delays in obtaining mining permission are not a significant factor contributing to the need for an Extension of Time (EOT).
$H12_a$: The respondents indicated that delays in obtaining mining permission are a significant factor contributing to the need for an Extension of Time (EOT).
$H13_o$: The respondents indicated that utility shifting is not a significant factor contributing to the need for an Extension of Time (EOT).
$H13_a$: The respondents indicated that utility shifting is a significant factor contributing to the need for an Extension of Time (EOT).
$H14_o$: The respondents indicated that labor shortages are not a significant factor contributing to the need for an Extension of Time (EOT).
$H14_a$: The respondents indicated that labor shortages are a significant factor contributing to the need for an Extension of Time (EOT).
$H15_o$: The respondents indicated that weather conditions are not a significant factor contributing to the need for an Extension of Time (EOT).
$H15_a$: The respondents indicated that weather conditions are a significant factor contributing to the need for an Extension of Time (EOT).
$H16_o$: The respondents indicated that pre-construction activities are not a significant factor contributing to the need for an Extension of Time (EOT).
$H16_a$: The respondents indicated that pre-construction activities are a significant factor contributing to the need for an Extension of Time (EOT).
$H17_o$: The respondents indicated that issues related to construction execution, material procurement, and workforce are not significant factors contributing to the need for an Extension of Time (EOT).
$H17_a$: The respondents indicated that issues related to construction execution, material procurement, and workforce are significant factors contributing to the need for anExtension of Time (EOT).

$H18_o$: The respondents indicated that post-construction activities such as testing, commissioning, and final approvals are not significant factors contributing to the need for an Extension of Time (EOT).
$H18_a$: The respondents indicated that post-construction activities such as testing, commissioning, and final approvals are significant factors contributing to the need for an Extension of Time (EOT).
$H19_o$: The respondents indicated that changes in government policies are not significant factors contributing to the need for an Extension of Time (EOT).
$H19_a$: The respondents indicated that changes in government policies are significant factors contributing to the need for an Extension of Time (EOT).
$H20_o$: The respondents indicated that economic instability is not a significant factor contributing to the need for an Extension of Time (EOT).
$H20_a$: The respondents indicated that economic instability is a significant factor contributing to the need for an Extension of Time (EOT).
$H21_o$: The respondents indicated that legal and regulatory delays are not significant factors contributing to the need for an Extension of Time (EOT).
$H21_a$: The respondents indicated that legal and regulatory delays are significant factors contributing to the need for an Extension of Time (EOT).
$H22_o$: The respondents indicated that social or community protests are not significant factors contributing to the need for an Extension of Time (EOT).
$H22_a$: The respondents indicated that social or community protests are significant factors contributing to the need for an Extension of Time (EOT).
$H23_o$: The respondents indicated that external factors are not significant contributors to the need for an Extension of Time (EOT).
$H23_a$: The respondents indicated that external factors are significant contributors to the need for an Extension of Time (EOT).
$H24_o$: The respondents indicated that conflicts between contractors are not significant factors contributing to the need for an Extension of Time (EOT).
$H24_a$: The respondents indicated that conflicts between contractors are significant factors contributing to the need for an Extension of Time (EOT).
H25o: The respondents indicated that delays in decision making by authorities are not significant factors contributing to the need for an Extension of Time (EOT).
H25a: The respondents indicated that delays in decision making by authorities are significant factors contributing to the need for an Extension of Time (EOT).
$H26_o$: The respondents indicated that miscommunication among project teams is not a significant factor contributing to the need for an Extension of Time (EOT).
$H26_a$: The respondents indicated that miscommunication among project teams is a significant factor contributing to the need for an Extension of Time (EOT).
$H27_o$: The respondents indicated that lack of coordination with local communities is not a significant factor contributing to the need for an Extension of Time (EOT).
$H27_a$: The respondents indicated that lack of coordination with local communities is a significant factor contributing to the need for an Extension of Time (EOT).

Data Analysis: Respondent Demographics

We received a total of 39 valid responses from stakeholders involved in infrastructure projects. The majority of the respondents were consultants, making up 53.8% of the group. This was followed by contractors or concessionaires at 38.5%, and a smaller share of employers, who accounted for 7.7% of the total (Figure 4.1).

To understand how professional experience influences the perception of project delays, we grouped the participants based on their years of experience: 0–5 years, 5–10 years, 10–15 years, and over 15 years(Figure 4.2).

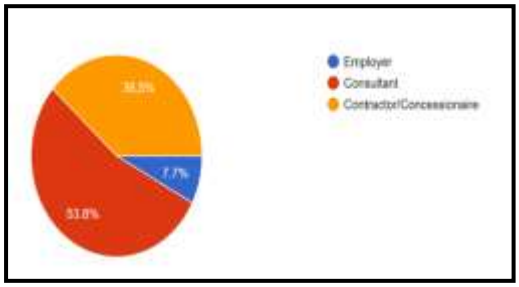

Fig. 4.1: Responses

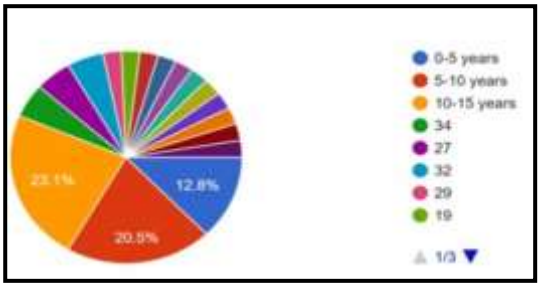

Fig. 4.2: Respondent Experience

Data Analysis: Data Validation and Reliability Testing

Before going into the survey results, it was important to make sure the data was consistent and reliable. This helps confirm that the participants understood the questions in a similar way and responded thoughtfully. To check this, we used Cronbach's Alpha to measure the internal reliability of the 31 delay factors included in the study. A strong score here gave us confidence that the responses were dependable and the data was ready for analysis as shown in the Table 1 and Table 2. The ANOVA results are depicted in Table 3.

Table 1: Case Processing Summary

		N	%
Cases	Valid	39	100.0
	Excluded	0	0.0
	Total	39	100.0

a. Listwise deletion based on all variables in the procedure.

Table 1: Reliability Statistics

Cronbach's Alpha	N of Items
0.905	31

The Cronbach's Alpha score for the survey was 0.905, indicating a high level of internal consistency and suggesting that the responses were reliable and the participants interpreted the delay factors in a similar way .

Data Analysis: Results

The measurement items for land acquisition exhibited acceptable internal consistency. The results indicate that respondents perceived land acquisition as a significant factor contributing to Extension of Time (EOT) in highway projects (4.59, $p < .01$), providing support for $H1_a$.

The measurement items for design approvals exhibited acceptable internal consistency. Respondents indicated that delays in design approvals significantly contribute to Extension of Time (EOT) in highway projects (4.143, $p < .05$), thereby supporting $H3_a$.

Delays in the commencement of ATMS work were perceived as a significant contributor to Extension of Time (EOT) in highway projects (3.085, $p < .05$), thereby supporting $H4_a$.

Changes in scope is perceived as a significant contributor to Extension of Time (EOT) in highway projects (6.564, $p < .05$), thereby supporting $H8_a$.

Weather conditions are perceived as a significant contributor to Extension of Time (EOT) in highway projects (3.009, $p < .05$), thereby supporting $H15_a$.

Pre-construction activities are perceived as a significant contributor to Extension of Time (EOT) in highway projects (3.736, $p < .05$), thereby supporting $H16_a$.

Issues related to construction execution, material procurement, and workforce are perceived as a significant contributor to Extension of Time (EOT) in highway projects (3.707, $p < .05$), thereby supporting $H17_a$.

Miscommunication among project teams is perceived as a significant contributor to Extension of Time (EOT) in highway projects (3.718, $p < .05$), thereby supporting $H26_a$.

Interpretation/s:

The results interpretation is as follows:

- land acquisition, design approvals, Delays in the commencement of ATMS work, Changes in scope, Weather conditions, Pre-construction activities, Issues related to construction execution, material procurement, and workforce and Miscommunication are leading to the extension of time.
- Considering the significant levels, the order of factors impacting the extension of time is Delay in approval of change in scope, Land Acquisition, Delay in Design Approvals, Pre-Construction activities, Construction Execution Material Procurement Work Force Issues, Delay in commencement of ATMS work and Weather Conditions.

Table 3: One Way ANOVA Analysis

ANOVA							
S.No.		F	Sig.	S.No.		F	Sig.
1	Delay in approval of change in scope	6.564	0.001	16	Electrical Utility shifting	1.372	0.267
2	Land Acquisition	4.59	0.008	17	Post Construction Testing Commissioning Final Approvals	1.201	0.324
3	Delay in Design Approvals	4.143	0.013	18	Client	1.179	0.332
4	Pre-Construction	3.736	0.02	19	Concessionaire	1.179	0.332

5	Construction Execution Material Procurement Work Force Issues	3.707	0.02	20	Consultant	1.165	0.337
6	Miscommunication Among Project Teams	3.718	0.02	21	Social or Community Protests	1.158	0.34
7	Delay in commencement of ATMS work	3.085	0.04	22	Delay in getting design approval for ROBs RUBs from the Railway	1.015	0.398
8	Weather Conditions	3.009	0.043	23	Economic Instability	0.838	0.482
9	Financial Constraints	2.318	0.092	24	External Factor	0.492	0.69
10	Environmental Clearances	2.302	0.094	25	Occurrence of Force Majeure Event	0.487	0.693
11	Conflicts Between Contractors	2.228	0.102	26	Delay in getting mining permission from state government	0.455	0.716
12	Labour Shortages	2.083	0.12	27	Legal and Regulatory Delays	0.432	0.731
13	Delays in Decision Making by Authorities	1.861	0.154	28	Changes in Government Policies	0.36	0.782
14	Lack of Coordination with Local Communities	1.487	0.235	29	Utility Shifting	0.235	0.871
15	Change in Scope	1.474	0.238	30	Delay in execution of Utility structures	0.118	0.949

Conclusion:
We believe that the title "Management of Claims in Infrastructure Projects" is fully justified based on the findings of this study. Managing Extension of Time (EOT) claims goes far beyond just ticking a procedural box—it plays a crucial role in ensuring the success and smooth delivery of infrastructure projects. Through our analysis, we found that delays related to land acquisition, design approvals, and changes in project scope are not only common but also significantly disruptive. These delay factors consistently emerged as valid grounds for EOT and highlight the importance of having clear and structured claim management systems in place. We also observed that different stakeholder groups—such as consultants, contractors, and employers—perceive delays differently depending on their roles and responsibilities. These differing views can lead to misunderstandings, disputes, and inconsistent handling of claims. That's why we strongly recommend improving contract clarity, encouraging open communication, and maintaining thorough documentation throughout the project lifecycle. In our view, good claim management practices help reduce delays, prevent conflicts, and foster stronger collaboration between public and private sectors. This study not only contributes valuable academic insights but also offers practical guidance for making infrastructure project delivery more efficient—especially under models like HAM, where managing risk fairly is essential.

Recommendations: The recommendation/s are as follows:

- **Increase the Geographic Scope:** Future researchers may increase the study to cover other regions or states in India to assess if the findings hold true across other geographies under the Hybrid Annuity Model (HAM).
- **Include Stakeholder-Specific Views:** Carry out comprehensive interviews or in-depth group discussions with NHAI authorities, concessionaires, contractors, and consultants to understand their functions better in Extension of Time (EOT) claims and contract administration practices.
- **Longitudinal Study Design:** A longitudinal study may be conducted to monitor projects over a period of time, observing how EOT claims change from project initiation to post-completion phases.
- **Digital Monitoring and Smart Contract Tools:** Future research can investigate the use of digital technologies such as project dashboards, Building Information Modelling (BIM), or smart contracts to further improve real-time monitoring of EOT claims and reduction of risks.
- **Comparative Study with EPC or BOT Models:** A comparative analysis of EOT provisions under HAM in comparison to other models of contracting (e.g., EPC, BOT) can help identify more insightful findings regarding which model provides improved delay management and risk sharing.
- **Judicial and Arbitration Case Analysis:** Future research can include scrutiny of legal/arbitration cases pertaining to EOT claims in HAM projects, in order to comprehend trends in dispute resolution and contractual interpretation.
- **Policy Review and Improvement:** Review recent policy revisions by NHAI and MoRTH impacting EOT and claim management and suggest frameworks for enhancing contractual enforcement and mitigation of delays.

REFERENCES

1. Al-Azad, N., Enegbuma, W. I., Bamgbade, J. A., Ohueri, C. C., Faculty of Engineering, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia, School or Architecture, Victoria University of Wellington, Wellington, New Zealand, & Faculty of Engineering, Computing

and Science, Swinburne University of Technology, Kuching, Malaysia. (n.d.). INFLUENCING FACTORS IN EXTENSION OF TIME CLAIMS. Conference: 43rd Australasian Universities Building Education Association ConferenceAt: Noosa Queensland, Australia.

2. Ghosh, B., & Karmakar, S. (2023). *Assessing the causes of claims in highway construction projects with a case study: A construction practitioner's perspective. Asian Journal of Civil Engineering, 25*, 3035–3048. https://doi.org/10.1007/s42107-023-00961-2
3. Jain, A., Khan, F., Gupta, P., Gupta, K., & Yadav, S. R. (2019). CHALLENGES FACED IN PPP AND HAM MODEL AND THE NEED FOR AN ALTERNATIVE. Journal of Civil Engineering Science and Technology, 10(2), 82–93. https://doi.org/10.33736/jcest.1407.2019
4. Jain, F., Khan, S., et al. (2019). Comparative Analysis of Highway Project Execution Models: Stakeholder-Based Study. Journal of Construction Engineering and Management, Volume 145, Issue 11.
5. Kumar, M., & Kumari, S. (2024). Empirical study on delays in highway projects: A comparative analysis of small and large projects. Shanlax International Journal of Management, 12(2), 15–25. https://doi.org/10.34293/management.v12i2.7945
6. Mohamad Yusuwan, N., & Adnan, H. (2013). Issues associated with extension of time (EoT) claim in Malaysian construction industry. Procedia Technology, 9, 740–749. https://doi.org/10.1016/j.protcy.2013.12.082
7. Mohamad, H. M., Mohamad, M. I., Saad, I., Bolong, N., Mustazama, J., & Mohd Razali, S. N. (2021). A case study of S-curve analysis: Causes, effects, tracing and monitoring project extension of time. Civil Engineering Journal, 7(4), 649–661. https://doi.org/10.28991/cej-2021-03091679
8. Nasir, Abdul, Gabriel, Omran, and Choudhry, Rafiq (2025). "Cost and Time Overruns in Highway Projects: Their Impact on Economic Growth in Pakistan", Pakistan Journal of Engineering and Applied Sciences, Volume 22, Issue 1.
9. O'Connor, J. T., Chmaytelli, A., & Hugo, F. (1993). Analysis of highway project construction claims. Journal of Performance of Constructed Facilities, 7(3), 219–237. https://doi.org/10.1061/(ASCE)0887-3828(1993)7:3(219)
10. Okereke, R. A., Zakariyau, M., & Eze, E. C. (2021). Extension of time (EoT) claims substantiation and associated issues in complex-multi stakeholders' building construction contracts. Journal of Engineering and Technology for Industrial Applications (ITEGAM-JETIA), 7(32), 23–31. https://doi.org/10.5935/jetia.v7i32.782
11. Osman, I., & Ataei, H. (2021). Studying construction claims due to COVID-19 for road and highway projects. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 14(1), 06521004. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000517
12. Rathore, A. (2021). Delay factor analysis for Indian HAM Highway construction projects. International Journal for Research in Applied Science and Engineering Technology, 9(12), 320–326. https://doi.org/10.22214/ijraset.2021.39242
13. Rathore, A., & Trivedi, M. K. (2021). Delay factor analysis for Indian HAM highway construction projects. International Journal for Research in Applied Science and Engineering Technology (IJRASET), 9(12), 3924–3929. https://doi.org/10.22214/ijraset.2021.39242
14. Senić, A., Dobrodolac, M., & Stojadinović, Z. (2024). Predicting extension of time and increasing contract price in road infrastructure projects using a Sugeno Fuzzy logic model. Mathematics, 12(18), 2852. https://doi.org/10.3390/math12182852
15. Taneja, A., & Kalra, R. (2019). Analysis of Hybrid Annuity Model in construction. CASS, 3(1), 61–66. https://onlinejournals-heb.pen-nic.in/cass/admin/freePDF/3igrrjkck0fd4b1vxp2v.pdf

16. Vajdic, N., Mladenovic, G., & Queiroz, C. (2023). Enhancing the feasibility of airport PPP projects with hybrid funding. Transportation Research Procedia, 69, 600–607. https://doi.org/10.1016/j.trpro.2023.02.213