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The Role of Contractual Provisions in Managing Delays and Disputes: A Review

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Abstract: Construction projects are inherently complex and often experience delays, significantly impacting timelines and costs. Effective delay management is crucial, with contracts playing a key role in defining responsibilities and remedies, including provisions like Extension of Time (EoT) clauses and liquidated damages to mitigate financial risks. Delay analysis techniques, such as Time Impact Analysis (TIA) and the Relative Importance Index (RII), are critical for identifying delay causes, assigning accountability, and ensuring fair dispute resolution. However, challenges like unclear contract language, poor record-keeping, and inconsistent analysis methods often complicate the resolution of disputes, leading to prolonged conflicts. Establishing clear documentation requirements, fostering strong communication among stakeholders, and adopting standardized delay analysis methods are vital for minimizing disputes and facilitating efficient resolutions. Furthermore, advancements in technology, including AI and Building Information Modelling (BIM), present opportunities to improve delay management and enhance contractual effectiveness. A well-structured contractual framework, supported by robust delay analysis and dispute resolution strategies, is essential for minimizing conflicts and ensuring the successful delivery of construction projects.

I. INTRODUCTION

A. Background

Construction projects are complex, involving multiple stakeholders, activities, and uncertainties, making delays common and often impactful. Even minor delays can have ripple effects, particularly in infrastructure projects that depend on factors like government approvals, weather, and supply chain coordination. To mitigate these risks, contracts define responsibilities, timelines, and remedies for delays. Key provisions like Extension of Time (EoT) clauses, liquidated damages, and force majeure address disruptions, while dispute resolution mechanisms like arbitration, mediation, and conciliation offer efficient alternatives to litigation, minimizing costs and time.

Effective contracts are essential not just for project delivery, but also for avoiding disputes. Disagreements over delay causes can lead to cost overruns and legal issues. To support these provisions, proper documentation and monitoring are critical. With advancements in technology, such as AI-based predictive tools, Building Information Modeling (BIM), and blockchain smart contracts, there's potential to improve delay management. However, existing contractual frameworks must evolve to incorporate these innovations and ensure smoother project execution in the future.

B. Problem Area

Although contracts contain provisions to manage delays, their implementation often faces challenges, such as unclear language, poor record-keeping, and differing interpretations of delays. For example, a contractor may

request an extension of time (EoT) due to supply chain issues, but if insufficient evidence is provided, the client might dispute the request. Similarly, liquidated damages clauses can become contentious if delays result from unforeseen events not covered in the contract. Delay analysis techniques like As-Planned vs. As-Built Analysis, Time Impact Analysis (TIA), and the Relative Importance Index (RII) help evaluate delays and assign responsibility. As-Planned vs. As-Built is useful for straightforward projects, while TIA is better for projects with frequent changes. RII helps prioritize delay causes based on their impact. However, these methods rely on accurate record-keeping and data, which are often missing in practice, and the lack of standardized delay analysis practices makes dispute resolution more complicated. When delays and such attributed issues are unable to be resolved through these analysis methods, disputes are likely to arise, leading to costly legal proceedings. Effective dispute resolution mechanisms, such as mediation, arbitration, and adjudication, become crucial to managing such conflicts and ensuring timely project completion.

The rapid development of AI, BIM, and smart contracts presents new opportunities to address these issues. AI can predict potential delays, while BIM offers real-time project tracking and collaboration. Blockchain technology enables automated enforcement of contract terms, minimizing human intervention. However, many traditional contracts are not yet designed to accommodate these innovations, highlighting the need for adaptive contractual frameworks.

II. CONTRACTS IN CONSTRUCTION PROJECTS: AN OVERVIEW

A. Types of Contracts

Understanding the various types of contracts in construction projects is essential, as each carries distinct implications for risk management and project execution. Common contract types include:

1. Lump Sum Contract (Fixed Price Contract): In this contract, the contractor undertakes the work for a fixed price. It is widely used for projects with well-defined scopes. For example, the construction of the Statue of Unity in Gujarat involved lump sum contracts for specific packages.
2. Cost Plus Contract: This contract reimburses the contractor for actual costs plus a fixed fee. It is often used for complex or unpredictable projects. For instance, ISRO's Chandrayaan-2 launch pad construction used cost-plus contracts for its highly technical and uncertain requirements.
3. Time and Material Contract (T&M): T&M contracts are used when the scope is unclear, and payments are based on time spent and materials used. For example, metro station interior works in Bangalore Metro often use T&M contracts for flexible execution.
4. Unit Price Contract: The payment depends on the quantity of work done, suitable for projects like roadworks. The Golden Quadrilateral Project adopted unit price contracts for different road sections.
5. Design-Build Contract: In this type, one entity handles both design and construction. The Mumbai Trans Harbour Link project follows a design-build contract to integrate design and execution seamlessly.
6. Integrated Project Delivery (IPD): IPD contracts foster collaboration among all stakeholders. The Tata Cancer Hospital in Kolkata adopted IPD principles to ensure efficient project delivery with shared responsibilities.
7. Guaranteed Maximum Price (GMP) Contract: This contract sets a cost ceiling, transferring risk to the contractor. The Indira Gandhi International Airport Terminal 3 construction in Delhi used GMP contracts to control costs.
8. EPC (Engineering, Procurement, and Construction) Contract: EPC contracts involve a single entity responsible for design, procurement, and construction. The Delhi-Mumbai Expressway uses EPC contracts for speed and efficiency in execution.
9. FIDIC Contracts: FIDIC-based contracts are used for international projects in India. The Chenab Rail Bridge Project in Jammu and Kashmir adopted FIDIC guidelines to manage its challenging terrain and technical complexities.
10. Framework Agreement: These agreements are used for recurring projects. For instance, National Highways Authority of India (NHAI) employs framework agreements for highway maintenance across the country.
11. Public-Private Partnership (PPP) Contract These contracts involve collaboration between the government and private entities. The Delhi Metro Rail Project Phase III is a successful example of PPP in India.
12. Public-Private Partnerships (PPPs): They are collaborative agreements where the government partners with private entities to develop and manage public infrastructure. The most common PPP models include Build-Operate-Transfer (BOT), where the private entity builds and operates the project before transferring it to the government, as seen in the Delhi-Gurgaon Expressway. Another popular model is Hybrid Annuity Model (HAM), which blends government funding with private sector efficiency, exemplified by the Nagpur-Mumbai Expressway. The Design-Build-Finance-Operate-Transfer (DBFOT) model involves private financing and operation before transfer to the government, such as the Yamuna Expressway. Each model is chosen based on project needs, financing, and operational requirements

B. Key Contractual Provisions Related to Delays and Disputes

Several important provisions address delays and disputes within construction contracts:

1. Obligation of the Authority: Ensure timely approvals and provide necessary resources to facilitate project progress.
2. Obligation of the Contractor: Complete the project on time and notify the authority of any delays as soon as they arise.
3. Extension of Time (EOT): Allows contractors relief for excusable delays beyond their control, ensuring fairness in project timelines.
4. Liquidated Damages: Pre-agreed penalties for delays that are not excused, providing clarity on consequences and protecting the owner's interests.
5. Force Majeure: Protects parties from unforeseen events that impede contract performance, allowing for equitable adjustments to obligations.
6. Change Order Provisions: Outlines procedures for managing changes in project scope, including adjustments to timelines and costs.
7. Dispute Resolution Clauses: Specifies methods for resolving conflicts, such as arbitration or mediation, to promote efficiency and minimize project disruptions.
8. Indemnification Clause: Requires the contractor to compensate the owner for certain damages, losses, or liabilities arising from the contractor's actions or negligence, thereby protecting the owner's financial interests

C. Role of Contractual Provisions in Managing Delays

Delays in construction projects are a common problem that can disrupt schedules and increase costs. Contracts often include specific provisions to manage these delays by setting conditions for granting extensions of time. These clauses clarify the responsibilities of all parties and provide a clear process for dealing with unexpected delays. By including requirements for notices, compensable delays, and liquidated damages, contracts create a structure that encourages accountability and reduces disputes. Proper management of these provisions helps keep projects on track and ensures everyone understands their roles and rights when delays happen.[1]

III. CONTRACTUAL CLAUSES RELEVANT TO DELAY MANAGEMENT

Contractual clauses play a vital role in managing delays in construction projects by providing a structured framework to address unexpected events. These clauses define the rights and responsibilities of all parties and outline the procedures to follow when delays occur. They typically cover aspects such as notice requirements, extension of time provisions, and conditions for submitting claims. By establishing clear guidelines, these clauses help minimize confusion, promote accountability, and reduce the likelihood of disputes. Effective use of these provisions ensures that delays are addressed systematically, maintaining transparency and enabling projects to stay on track despite unforeseen challenges.[2]

A. Delay and Disruption Clauses

Delay and disruption clauses are important parts of construction contracts that help deal with unexpected events that can affect project schedules. These clauses explain what counts as a delay and provide steps for informing the involved parties about it. They also specify which types of delays can be compensated, such as those caused by external issues or changes to the project. As per FIDIC guidelines, contractors usually need to give notice of any delay within a set time, often within 28 days of knowing about the issue. Failing to do so may result in losing the right to claim extra time or compensation, making timely communication essential for managing delays effectively.

B. Notice Provisions and Claim Submission Timelines

Notice provisions are an important part of construction contracts that help contractors protect their claims for delays and disruptions. These provisions require contractors to inform project owners or managers about any events that might delay the project. The timing and way the notice is given are very important. Most contracts set deadlines for giving notice, which can range from 48 hours to 30 days, depending on the situation. For example, the AIA A201 contract says contractors must give notice within 21 days of the event. If these timelines are not followed, contractors may lose their right to claim extra time or money. This makes clear communication and proper documentation very important during the project.

C. Extension of Time (EOT) Clauses

Extension of time (EOT) clauses are essential provisions in construction contracts that allow contractors to request extra time for project completion when delays occur due to factors beyond their control. These clauses generally define the circumstances under which an EOT may be granted, such as bad weather, changes in design, or changes in the scope of the project, as well as other unforeseen events. Contractors are typically required to submit a detailed claim for an EOT within a specific time frame after becoming aware of the delay-causing event. For instance, FIDIC contracts specify that claims for extensions must be made within 28 days, along with supporting documentation to justify the request. This approach helps ensure that claims are evaluated fairly while keeping all involved parties updated on the potential impact on the project's timeline.

D. Delay Damages Clauses

Delay damages clauses are a key part of construction contracts, designed to hold contractors accountable for delays that impact the project's completion date. These clauses specify the penalties contractors will face if they fail to finish the project on time. The most common form of delay damages is liquidated damages, where a fixed amount is agreed upon in advance for each day the project is delayed beyond the scheduled completion date. These

damages are intended to compensate the owner for the inconvenience or extra costs caused by the delay. However, the amount must be reasonable and based on the actual expected damages, as excessive penalties may be considered unenforceable in some jurisdictions. The presence of delay damages clauses motivates contractors to stay on schedule and helps project owners manage the financial risks associated with delays. While these clauses can be an effective tool for managing time-related issues, they also require clear and fair agreement terms to ensure that both parties are protected and treated equitably.

E. Claims, Disputes and Arbitration

Claims, disputes, and arbitration are essential components of construction contracts, offering structured methods for resolving conflicts that arise during the project. Claims are formal requests made by one party for compensation, an extension of time, or other relief due to delays, disruptions, or other issues that affect the project. Disputes often emerge when these claims are not resolved through regular communication or negotiation. In such cases, arbitration, a form of Alternative Dispute Resolution (ADR), is commonly used to settle disagreements. Arbitration provides a more flexible, faster, and cost-effective solution compared to traditional court litigation. Both parties present their claims and evidence to an impartial arbitrator or panel, who then makes a binding decision. The process is governed by established rules, which can be adapted to fit the specifics of the dispute. As part of ADR, arbitration is increasingly favoured in construction disputes due to its confidentiality, speed, and ability to provide a final, enforceable resolution, reducing the likelihood of prolonged conflicts and delays.

IV. PROACTIVE VS. REACTIVE DELAY MANAGEMENT

Aspect	Proactive Delay Management	Reactive Delay Management
Definition	Focuses on identifying and addressing potential risks or delays before they occur.	Involves resolving and mitigating the impacts of delays after they have already affected the project.
Approach	Relies on planning, forecasting, and preventive measures to avoid disruptions.	Centres on corrective actions, addressing the consequences of delays to minimize further disruptions.
Focus	Aims to prevent delays from occurring, ensuring uninterrupted project progress.	Focuses on managing and resolving existing delays to recover lost time and control project damage.
Key Tools	Includes schedule monitoring, regular risk assessments, detailed resource allocation, and early warning systems.	Employs delay analysis techniques, claims preparation, time extensions, and dispute resolution mechanisms.
Benefits	Enhances efficiency, reduces risks, and maintains project timelines and budgets with minimal disruptions.	Provides a structured way to manage delays, enabling the recovery of project schedules and protecting stakeholder interests.
Common Techniques	Regular progress reviews, real-time tracking of milestones, communication protocols, and contingency planning.	Use of contractual clauses, preparation of delay claims, extension of time requests, and reliance on arbitration or mediation.
Impact on Budget	Cost-effective as it identifies risks early and avoids expensive corrective actions.	May result in cost overruns due to unplanned expenditures on claims, dispute resolution, or expedited work.
Timing	Applied consistently throughout the project lifecycle, starting from the planning phase.	Activated only after a delay is identified, often during the execution phase or later stages of the project.
Stakeholder Involvement	Encourages active collaboration between contractors, owners, and consultants to anticipate and mitigate risks.	Typically involves contractors, project owners, and third parties (e.g., arbitrators) to resolve specific disputes.

Effectiveness	More effective in ensuring project success by reducing disruptions and maintaining stakeholder confidence.	Helps manage immediate crises but often results in temporary fixes rather than long-term solutions.

A. Reactive Strategies: Managing Claims and Extensions in Construction Projects

In construction projects, reactive strategies play a crucial role in managing delays and disputes that arise during execution. These strategies, often involving claims and extensions of time (EOT), help address unexpected issues while maintaining contractual fairness.

B. Key Elements of Reactive Strategies

Claims and extensions of time (EOT) are central to reactive strategies in construction. Contractors may file claims to recover from delays caused by unforeseen events like adverse weather or scope changes, provided they present detailed documentation showing the delay's impact. EOT clauses in contracts specify conditions such as force majeure or owner-initiated changes, ensuring contractors are not unfairly penalized. To address disputes arising from claims or extensions, contracts often include arbitration or mediation provisions, enabling timely and efficient conflict resolution while minimizing disruptions.[3]

C. Importance of Proper Documentation

Thorough documentation strengthens reactive strategies:

1. Project Records: Regular updates on milestones can serve as proof when delays occur.
2. Communication Logs: Keeping records of discussions about delays or changes supports claims effectively

D. Challenges in Implementing Reactive Strategies

Despite their importance, reactive strategies often face hurdles:

1. Unclear Contract Terms: Ambiguities about delays or EOT conditions can cause conflicts.
2. Late Claims: Missing deadlines for submitting claims can lead to losing entitlement to extensions or compensation.
3. Resistance from Stakeholders: Disputes may arise when parties hesitate to acknowledge claims due to financial concerns.

Reactive strategies, backed by clear contracts and robust documentation, are essential for managing unforeseen challenges while preserving project progress and fairness among stakeholders.

V. LITERATURE REVIEW

A. Review of Construction Contract Provisions

Adel L Eldosouky et al provides (2022) a detailed examination of the causes of disputes in construction contracts, with a particular focus on Egyptian infrastructure projects. The study identifies sixteen key factors contributing to disputes, including unclear contract conditions, delayed payments, and insufficient compensation for change orders. These factors are validated through interviews with industry experts. The paper stresses the importance of clear contractual terms and defined responsibilities, especially regarding safety and site conditions, to prevent conflicts. The conclusion suggests that the Egyptian Construction Contracts (ECC) should be revised to address these issues, ultimately improving project outcomes such as cost, time, quality, and safety, while reducing disputes between employers and contractors. The research calls for a contract drafting approach tailored to the specific cultural and operational context of the Egyptian construction market.[4]

Ruqaya S. Al-Sabah et al (2024) explores the nature of contract disputes in construction, emphasizing the critical need for clear contractual terms and effective communication between all parties involved. The research focuses on claims management processes, the importance of timely notifications, and the consequences of non-compliance with contractual obligations. The paper compares the dispute resolution mechanisms of FIDIC and GCC contracts, highlighting differences in arbitration rules and language requirements. The authors conclude that harmonizing contract conditions is crucial for creating a more predictable construction environment in the GCC region, advocating for proactive measures such as better risk management and adherence to contractual timelines to minimize disputes. This examination provides valuable insights into construction contracts and strategies for reducing disputes.[5]

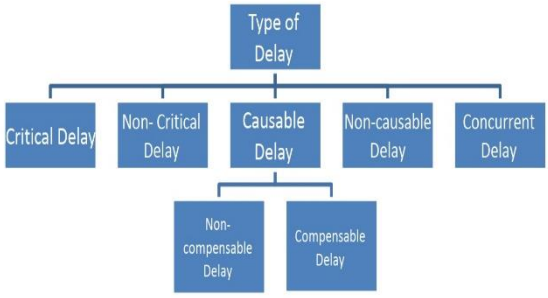
Mohamed Abdel-Hamid D et al (2022) examines the shortcomings of traditional ad-hoc contracts in the Egyptian construction industry, which often lead to disputes due to poorly drafted agreements and weak contract management. The research highlights several causes of delays and disputes, including financial issues, design changes, and ineffective management practices. The paper recommends adopting the FIDIC 2017 contract framework, which provides a more structured approach to dispute prevention and aligns with the principles of the Egyptian Civil Code. Key areas of focus include the need for clear and precise contract clauses, the selection of competent contractors, and effective project management practices. The conclusion argues that implementing the FIDIC 2017 framework can reduce arbitration cases and financial losses, ultimately fostering a more collaborative and efficient construction environment in Egypt.[6]

Saad Alotaibi B et al (2024) discusses the legal and contractual challenges involved in adopting Building Information Modeling (BIM) in the construction industry. The study highlights the need for clear contractual frameworks that specify responsibilities and intellectual property (IP) rights, as well as the importance of legal awareness among stakeholders. It also addresses the critical role of effective dispute resolution mechanisms to avoid conflicts. While BIM offers benefits like increased efficiency and collaboration, it introduces complexities related to risk management and IP allocation. The research suggests that comprehensive strategies and standardized frameworks, along with collaboration among industry professionals, are essential to ensure successful BIM implementation and improve construction practices.[7]

Issaka Ndekugri et al (2015) critically examines the challenges associated with adjudication processes in the context of the NEC3 Engineering and Construction Contract, focusing on disputes that arise after the completion of a project. The study emphasizes the NEC3 philosophy, which promotes early resolution of claims and disputes and highlights the importance of trust and cooperation between the parties involved. Key issues discussed include the necessity of timely notifications regarding compensation events, the effects of adjudication decisions, and the potential for prolonged disputes if not managed effectively. The research suggests that future versions of the NEC3 contract should incorporate provisions for clearer time-bar notifications, introduce conclusive evidence clauses to discourage delayed challenges, and ensure adjudicator decisions are binding if not referred to a tribunal within a set time. These changes aim to improve dispute resolution efficiency and reduce the risk of extended claims, ultimately benefiting project owners and other stakeholders in the construction sector.[8]

B. Delay in Construction Projects:

Abdulla M Tawfek et al (2018) explains that a delay in construction projects arises when the time needed to complete the work surpasses the duration outlined in the contract or mutually agreed upon by the parties. This leads to a deviation from the planned Schedule, often resulting in the late completion of the project.[9]



Sadi A. Assaf et al (2004) Defines delay as a time overrun beyond the completion date specified in the Contract or agreed upon for project delivery, representing common challenge in the construction where schedules are disrupted. Delays can arise from various sources, including owner-related issues like scope changes or "change orders", contractor-related problems such as poor planning and site management and external factors like regulatory changes, traffic issue, or accidents during construction. Shortage in material or skilled labour, along with delays in deliveries, can further exacerbate the problem, as an economic fluctuation such as inflation or increased labour costs, which may extend timeline or elevate overheads. Additionally, consultant-related inefficiency or decisions can impact project progress, underscoring the multifaceted nature of delays in construction projects.[10]

C. Causes of Delays

Guillermo Mejia et al (2019) explored a wide range of delay causes in road infrastructure projects, organizing them into ten distinct groups related to various project management topics and stakeholders. From an analysis of 14 primary studies, 140 specific delay causes were identified, with financial issues emerging as the most common, representing 17.1% of all reported delays. Key financial-related factors included delayed payments to contractors and financial struggles faced by contractors. Other major categories contributing to delays were planning challenges, material and equipment shortages, and contractual disputes, illustrating the diverse and interconnected nature of project delays in developing countries. The study highlights that delay causes differ considerably depending on the economic and geographic context of each country, underscoring the importance of developing region-specific strategies to mitigate these challenges effectively.[11]

Table 2. Frequency of delays by project management topics (N = 140). Source: self-elaboration.

Delay Causes by Category		Frequency	Percentage (%)
Financial issues (24/140 = 17.1%)			
C01	Payment delays to contractor	10	7.1
C02	Financial difficulties of contractor	5	3.6
C03	Financial difficulties of owner	9	6.4
Contract management and skills (19/140 = 13.6%)			
C08	Lack of owner's management skills	2	1.4
C13	Inadequate contractor's experience	6	4.3
C35	Poor contract management	1	0.7
C36	Unrealistic contract duration	3	2.1
C37	Claims and disputes with stakeholders	2	1.4
C38	Poor communication with stakeholders	5	3.6
Change management (15/140 = 10.7%)			
C05	Change orders due to the owner	2	1.4
C06	Scope changes due to the owner	2	1.4
C10	Late decision making by owner	5	3.6
C16	Late decision making by consultants	2	1.4
C22	Project scope changes	4	2.9
Project planning issues (15/140 = 10.7%)			
C09	Land acquisition	3	2.1
C20	Inadequate project planning	6	4.3
C21	Lack of project planning	1	0.7
C23	Inadequate bidding method	2	1.4
C33	Poor site investigation	3	2.1
Site management (15/140 = 10.7%)			
C11	Delayed activities	5	3.6
C12	Inadequate construction methods	1	0.7
C14	Poor site management and supervision	7	5.0
C31	Delay of site mobilization	2	1.4
External influences (15/140 = 10.7%)			
C39	Late permits by local authorities	2	1.4
C40	Economy issues	3	2.1
C41	Political situation	4	2.9
C42	Unethical activities	2	1.4
C43	Weather	4	2.9
Equipment and materials issues (13/140 = 9.3%)			
C04	Price variation of materials	2	1.4
C29	Shortage of equipment	6	4.3
C30	Shortage of materials	5	3.6
Design issues (10/140 = 7.1%)			
C07	Late approval of shop drawings and sample materials	2	1.4
C17	Delays of design	1	0.7
C18	Design changes	3	2.1
C19	Failures in design	4	2.9
Project characteristics (7/140 = 5.0%)			
C24	Project size	1	0.7
C32	Ground conditions	3	2.1
C34	Relocation of underground utilities	3	2.1
Workforce/Labor Issues (7/140 = 5.0%)			
C25	Low labor productivity	4	2.9
C26	Shortage of labor	2	1.4
C27	Staffing problems	1	0.7

Table 3. Frequency of delays by stakeholder (N = 140). Source: self-elaboration.

Delay Causes by Category		Frequency	Percentage (%)
Owner (50/140 = 35.7%)			
C01	Payment delays to contractor	10	7.1
C03	Financial difficulties of owner	9	6.4
C05	Change order due to owner	2	1.4
C06	Scope change due to owner	2	1.4
C08	Lack of owner's management skills	2	1.4
C09	Land acquisition	3	2.1
C10	Late decision making by owner	5	3.6
C20	Inadequate project planning	7	5.0
C22	Project scope changes	4	2.9
C23	Inadequate bidding method	2	1.4
C24	Project size	1	0.7
C36	Unrealistic contract duration	3	2.1
Contractor (32/140 = 22.9%)			
C02	Financial difficulties of contractor	4	2.9
C11	Delayed activities	6	4.3
C12	Inadequate construction methods	1	0.7
C13	Inadequate contractor's experience	7	5.0
C14	Poor site management and supervision	5	3.6
C25	Low labor productivity	1	0.7
C27	Staffing problems	5	3.6
C31	Delay in site mobilization	1	0.7
C35	Poor contract management	2	1.4
External Agent (24/140 = 17.1%)			
C04	Price variation of materials	2	1.4
C37	Claims and disputes with stakeholders	2	1.4
C38	Poor communication with stakeholders	5	3.6
C39	Late permits by local authorities	2	1.4
C40	Economy issues	3	2.1
C41	Political situation	4	2.9
C42	Unethical activities	2	1.4
C43	Weather	4	2.9
Designer and Consultant (21/140 = 15.0%)			
C07	Late approval of shop drawings and sample materials	2	1.4
C16	Late decision making by consultants	2	1.4
C17	Delays of design	1	0.7
C18	Design changes	3	2.1
C19	Failures of design	4	2.9
C32	Ground conditions	3	2.1
C33	Poor site investigation	3	2.1
C34	Relocation of underground utilities	3	2.1
Supplier and Subcontractor (13/140 = 9.3%)			
C26	Shortage of labor	2	1.4
C29	Shortage of equipment	6	4.3
C30	Shortage of materials	5	3.6

Tsegay Gebrehiwet (2017) highlights several critical causes of delays in construction projects grouping them into external, responsibility-related and contract-related categories. External factors include issues such as corruption and the unavailability of utilities at the site. Responsibility-related delays often stem from clients 'financial constraints and poor communication, while contractors face challenges like inadequate site management and ineffective planning. Resource related causes revolve around material shortages and financial limitations, whereas contract-related delays are linked to unrealistic project durations and insufficient penalty provisions. These interconnected factors emphasize the complexity of construction delays, requiring holistic strategies for effective mitigation.[12]

Adebayo Fashina (2021) analyses a number of factors that contribute to construction project delays in Hargeisa. Inadequate funding, late contractor payments, and design modifications are examples of owner-related delays. Financial difficulties, inexperience, and inadequate site management are the main causes of contractor-related delays. Poor communication and delays in delivering required approvals and designs are the main causes of consultant-related delays. Labor disputes and a lack of skilled workers are examples of labor-related delays. When materials are scarce or delivered late, material-related delays happen. Delays caused by equipment malfunctions or a shortage of essential machinery occur. Finally, the project timeline may also be impacted by outside variables like bad weather and delays in regulations. The study highlights how these elements are interconnected and have a significant impact on overall success and schedule of construction projects.[13]

Hesham S. Ahmad et al (2020) categorizes the causes of delays in public infrastructure projects into several key groups. Owner-related factors include delays in processing payments, changes in specifications, slow decision-making, and failure to provide access to the site or approve materials on time. It also involves delays in delivering project site clearance, issues with the study of drawing documents, and time gaps between the drawing and execution phases. Contractor-related factors include financing problems, poor site management, ineffective planning, and inadequate technical staff qualifications. Labor-related delays are caused by unqualified workers and worker availability. Equipment-related delays stem from low productivity and inefficient equipment. External factors include mismatches between infrastructure services and what was approved in the tender, land acquisition issues, poor cooperation from utility owners, weather conditions, social and cultural factors, traffic restrictions, accidents, unforeseen ground conditions, and changes in government policies or economic conditions, such as rising material prices. The study emphasizes the

interconnectedness of these factors and their significant impact on project timelines[14]

S.K.Patil et al (2013) identifies several factors contributing to delays in transportation infrastructure projects in India, categorized by stakeholders involved. Consultant-related delays stem from slow responses to contractor inquiries, insufficient data collection before the design phase, and delays in approval for major scope changes. Contractor-related delays arise from poor site management, coordination issues, inadequate planning, unqualified technical staff, and the lack of high-tech equipment. Client-related causes include delays in financial closure, frequent change orders, slow payment processes, delayed decision-making, and poorly drafted contract documents. Additionally, land acquisition problems, environmental impact assessments, and social or cultural factors are significant contributors to delays. The study highlights the interconnected nature of these factors and their substantial impact on project timelines.[15]

D. Delay Analysis Technique in Construction Projects

Hoda Abou Orban et al (2018) discusses various delay analysis techniques (DAT) used in construction projects, focusing on their application, selection criteria, and industry preferences. Common techniques include Time Impact Analysis (TIA), which assesses delays by comparing schedules before and after the event; Window Analysis, which examines delays within specific time frames; As-Planned vs. As-Built Analysis, a retrospective method comparing planned and actual progress; and Collapsed As-Built Analysis, which reconstructs schedules assuming the delay did not occur. The choice of technique depends on factors such as project phase, data availability, complexity, and the type of delay. The paper highlights that TIA and Window Analysis are particularly suitable during project execution, as they integrate schedule changes for more accurate assessments. Retrospective methods, while simpler to use at project completion, may lack reliability due to complexities. Industry surveys and expert interviews emphasize the importance of selecting techniques based on the specific project context. The study concludes that choosing an appropriate DAT requires careful evaluation to improve delay management and minimize disputes effectively.[16]

Table 2: Comparison of the different DATs (Stumpf, 2000)

DAT	Strengths	Weaknesses
As-planned versus as-built	• Technically simple to perform if as-built schedule is available.	• Doesn't identify criticality or concurrency of delays • Assumes accurate baseline schedule logic
Impacted as-planned	• Easy and quick to prepare	• Assumes a perfect baseline schedule that was followed accordingly without any changes. • Results in magnified delays due to simplified scheduling planners usually make.
Collapsed as-built	• Easy and quick to prepare if there is a reliable as-built schedule.	• Analyst has to identify the as-built critical path. • Analyst has to make adjustments and insert logical ties as delays are removed.
Contemporaneous period analysis	• Highly accurate, causes the least controversy. • Uses schedule updates so gives a more realistic effect of the delay	• Time consuming to perform. • Requires sufficient project documentation

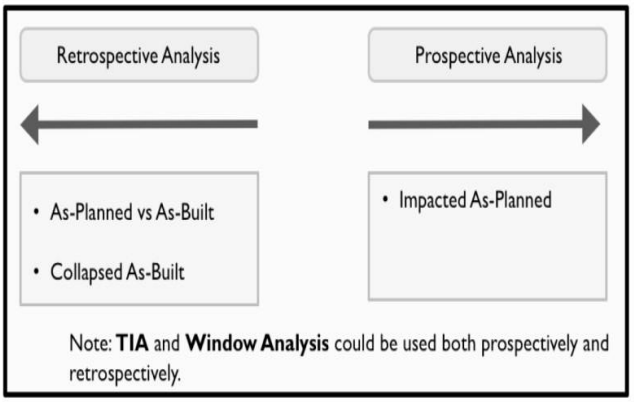


Figure 1: Categorization of Delay Analysis Techniques

Table 1: Comparison of the different DATs

DAT	Differentiates delay types	Addresses concurrent delays	Uses Real Time CPM
Global Impact	-	-	-
Net impact	-	Yes	-
Adjusted as-built CPM	-	Yes	-
'But for' or collapse	Yes	Yes	-
Snapshot	-	Yes	Yes
Time impact	-	-	Yes
Isolated delay type	Yes	Yes	Yes

Abanoub Wasfy et al (2021) provides an overview of various delay analysis techniques commonly used in construction projects, highlighting their strengths, limitations, and practical applications. Methods such as the Critical Path Method (CPM), Time Impact Analysis (TIA), Windows Analysis, As-Planned vs. As-Built Analysis, and expert judgment are discussed. CPM is recognized for its ability to define project timelines but is often time-intensive and costly. TIA, on the other hand, offers a structured

approach to measuring delays but depends on the frequency of its application. The selection of an appropriate technique plays a critical role in determining outcomes related to compensation, liability, and adjustments to project schedules while aiding in standardizing decisions in disputed situations. The review emphasizes that the chosen method must align with the project's specific conditions, including data availability and contractual obligations, to enhance delay management and support effective project execution.[17]

Amin Sherif et al (2022) explores various delay analysis techniques used in construction projects, focusing on their practicality and relevance to different project scenarios. Time Impact Analysis (TIA) stands out as a proactive and widely recommended method for evaluating delays, as it effectively predicts their potential impact on timelines. Other techniques, such as Collapsed As-Built, As-Planned vs. As-Built, Impacted As-Planned, and Windows Analysis, offer distinct approaches, like comparing planned schedules to actual progress or segmenting timelines to pinpoint specific delay causes. The study employed a survey-based quantitative approach, collecting insights from over 100 industry professionals and analysing the data using SPSS software. Findings reveal that design and consultant-related issues are key delay factors, with TIA being the most preferred method for addressing delays during critical project phases such as mobilization, construction, and closeout. Overall, the research emphasizes the need for a structured approach to selecting delay analysis techniques, tailored to the project's unique challenges, to improve delay management and claims resolution in the construction industry.[18]

Waqar Ahmad Paray et al (2020) emphasized the categorization of delay causes in construction projects, identifying key contributors such as owners, contractors, labour, equipment, and materials. Techniques like the Relative Importance Index (RII) and the 80/20 rule were highlighted as effective methods to rank the severity of these causes. Commonly cited issues included unforeseen site conditions, strikes, delays in government approvals, and unfavourable working environments, all of which significantly impact project timelines. The effects of these delays were noted to include time and cost overruns, strained stakeholder relationships, financial challenges, and increased disputes. To address these challenges, strategies were recommended such as detailed planning, thorough vendor assessments, and fostering regular communication among project stakeholders. These approaches were presented as essential steps to minimize delays and enhance the efficiency of construction projects.[19]

Surbhi Singh et al (2022) utilizes the Relative Importance Index (RII) method to assess the impact of various factors contributing to delays in construction projects. The RII method quantifies the significance of each factor based on responses from construction site personnel via a structured questionnaire. The study identified the top five delay factors, ranked by their RII values: the first factor with an RII of 0.60, the second with 0.59, the third with 0.52, the fourth with 0.48, and two factors tied at 0.43. The delays are mainly caused by issues with contractors, engineers, managers, and clients, along with poor communication between owners and clients. Additional factors include weather conditions, operator inefficiency, and challenges related to materials, equipment, and manpower. This analysis offers valuable insights into the causes of delays and emphasizes the need for effective management to enhance project timelines and efficiency.[20]

Alena Vasilyeva-Lyulina et al (2015) discusses the Additive Approach to delay analysis in construction projects, which assesses the impact of delay events on project completion using the "what-if" principle. This method requires a reliable as-planned programme as a baseline for comparison. The methodology involves the use of the Critical Path Method (CPM) to create two versions of the project schedule: the baseline programme and the impacted programme, which includes delays. Delay events are represented as additional activities or extensions of existing tasks, referred to as fragnets, to clearly illustrate their impact. The difference in completion times between the pre-impacted and impacted programmes quantifies the additional duration caused by the delays. The Additive Approach provides a systematic cause-and-effect relationship, essential for supporting claims for extensions of time and financial compensation. Its simplicity and effectiveness in demonstrating the impact of delay events, including both Employer's and Contractor's risk events, make it widely used in practice. By formalizing delay analysis methods, the paper aims to reduce ambiguity and minimize disputes, enhancing the reliability of delay analysis in construction projects.[21]

Jyh Bin Yang et al (2011) presents the Effect-Based Delay Analysis Method (EDAM), a modern approach designed to overcome the challenges of traditional methods used in analysing construction delays. EDAM simplifies the process by systematically breaking the project into time frames and focusing on how delays impact the critical path, which directly affects the project's completion. It classifies delays into three categories: Non-Excusable (NE), Excusable Compensable (EC), and Excusable Non-Compensable (EN), making it easier to determine responsibility for delays. The method also identifies concurrent delays and changes to the critical path, reducing the time and effort compared to older techniques. Its clear system for assigning responsibility helps avoid confusion and supports fair resolution of disputes. EDAM has proven useful in real-world projects, helping managers better handle delays and improve project outcomes. By addressing the effects of delays on interconnected activities, it provides a reliable and straightforward way to analyse and manage construction delays.[22]

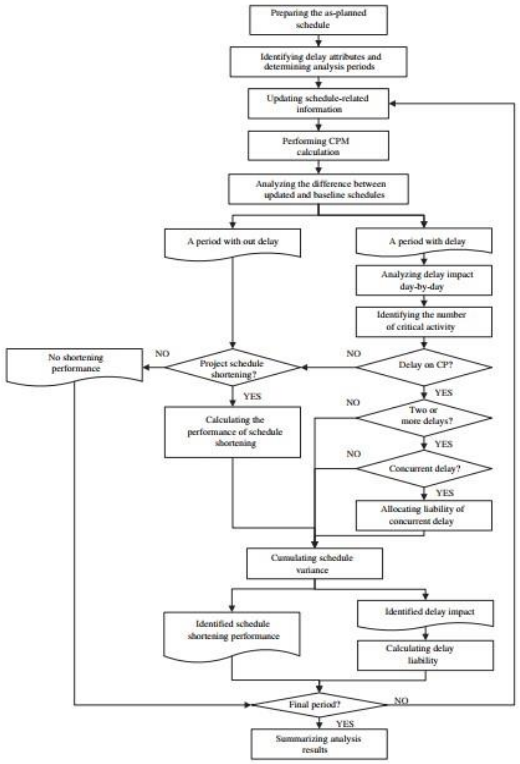
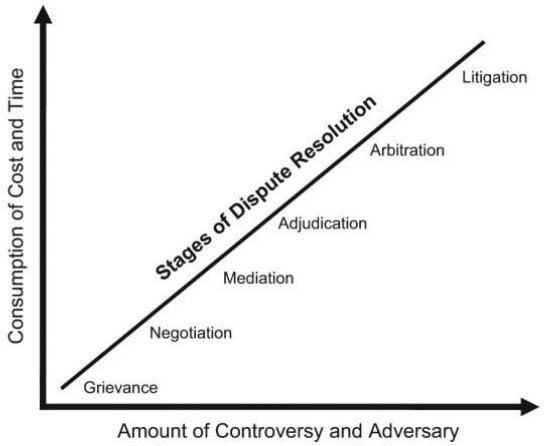


Fig. 1. Delay analysis processes for EDAM.

E. Dispute resolution mechanism

Heap-Yih Chong et al examines the common dispute resolution methods in the Malaysian construction industry, such as negotiation, mediation, adjudication, arbitration, and litigation. Negotiation and mediation are popular because they are less confrontational, while adjudication is less favoured. Arbitration and litigation remain widely used due to their familiarity and established processes. The study highlights the benefits of alternative dispute resolution (ADR), though its effectiveness is sometimes questioned due to unpredictable outcomes. It suggests introducing clear ADR guidelines in construction contracts to close the gap between theoretical knowledge and industry practices. The research emphasizes the importance of streamlining dispute resolution processes to encourage collaboration and improve project success.[23]



Item	Factors affecting the selection of dispute resolution methods	Negotiation	Mediation	Adjudication	Arbitration	Litigation
1	Non complex dispute	•	•			
2	Controlling of the process by the parties	•	•			
3	Helping the parties to understand each other demands	•	•			
4	Fair treatment of both parties during the negotiation process prior to any official hearing and ruling	•	•			
5	The parties are free to look for other dispute resolution methods (without legal liability) if they are not satisfied with the result	•	•			
6	Voluntary process	•	•			
7	Speedy of the process	•	•	•		
8	Economical	•	•	•		
9	Preservation of relationship	•	•	•		
10	Resolving the dispute without involving legal profession	•	•	•		
11	Meeting the budget and schedule of the process	•	•	•		
12	Flexibility of the process	•	•		•	
13	Providing the parties with the relevant information background in the process for consensus agreement		•			
14	Third party helps to negotiate and narrow down the issues		•	•		
15	Providing a qualified, neutral expert to hear complex matter		•	•	•	
16	Improvement of cash flow			•		
17	Confidentiality of the process			•	•	
18	Saving in trial expenses			•	•	
19	Finality of the settlement			•	•	
20	Privacy of the process are protected			•	•	
21	Expert judgment in construction of those involved in the process			•	•	
22	Complex dispute			•	•	•
23	Enforceability of the decision			•	•	•
24	Bindingness of the decision			•	•	•
25	Ability to appeal if not satisfy with the result			•	•	•
26	Long period of the process				•	•
27	Formality of the process				•	•

Sina Safinia et al (2014) outlines several dispute resolution methods in the UK construction industry, including negotiation, mediation, adjudication, arbitration, and litigation. Negotiation is a quick, low-cost, informal method that preserves relationships but is non-binding. Mediation also preserves relationships with a neutral third party, resulting in a non-binding agreement. Adjudication is a faster, semi-formal process with a binding decision, while arbitration is more structured, moderate in cost and time, and provides a binding award, though it may strain relationships. Litigation is the most formal and costly, offering a legally binding judgment but often damaging relationships. The choice of method depends on the dispute's nature, highlighting the importance of communication and early intervention to prevent conflicts.[24]

Sai-On Cheung et al (2002) focuses on identifying and prioritizing the critical attributes of Alternative Dispute Resolution (ADR) processes within the construction industry in Hong Kong. The study employs a hierarchical model to assess 19 attributes, using a structured prioritization exercise with 20 expert practitioners. A pilot study was conducted to refine the process, with data collected through face-to-face interviews using a 9-point pairwise comparison scale. The results identified the top 10 critical attributes, including voluntariness, confidentiality, neutrality, and preservation of relationships, with "voluntariness" receiving the highest weight of 0.398. Experts highlighted the importance of neutral third parties in facilitating settlements and emphasized the need for parties' commitment to the ADR process. These findings offer valuable insights into effective dispute resolution strategies and provide a foundation for future ADR research.[25]

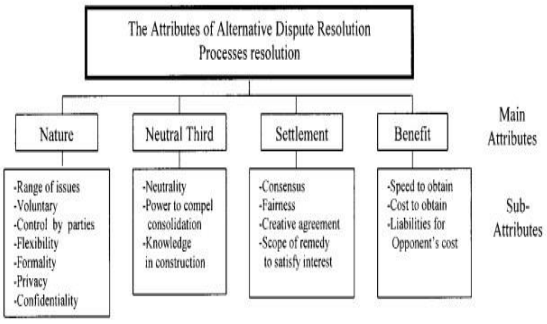


Fig. 1. Hierarchical structure of ADR attributes

J Richard Cheeks et al (2003) discusses the evolution of the construction industry's dispute resolution process, which has shifted from a traditional two-step approach involving an engineer's determination and binding arbitration to a more comprehensive multistep framework. This new approach includes loss prevention, direct negotiations, facilitated negotiations with neutrals, issue-specific mediation, and binding adjudication. By addressing disputes at earlier stages, the multistep process improves efficiency, reduces transaction costs, and preserves professional relationships that might otherwise be strained in lengthy litigations. It allows parties to choose and combine methods tailored to their specific needs, preventing many disputes from escalating and promoting a collaborative environment based on trust and respect. This shift towards a flexible and proactive dispute resolution system is increasingly recognized for its positive impact on time, cost, and relationship management in the construction industry.[26]

Thomas B. Treacy et al (1995) highlights various Alternative Dispute Resolution (ADR) methods used in the construction industry, including arbitration, mediation, early neutral evaluation, and dispute review boards (DRBs). These methods are typically more cost-effective and time-efficient compared to traditional litigation. Mediation and early neutral evaluation encourage collaboration and preserve relationships by offering non-binding resolutions, while arbitration, although binding, can be as formal and expensive as litigation. DRBs, made up of experts, provide timely recommendations during ongoing projects, ensuring disputes are resolved quickly and effectively. Overall, the use of ADR improves communication and cooperation among parties, leading to more satisfactory outcomes, making it an essential strategy for managing construction disputes.[27]

F. Findings on Dispute Resolution from Previous Studies

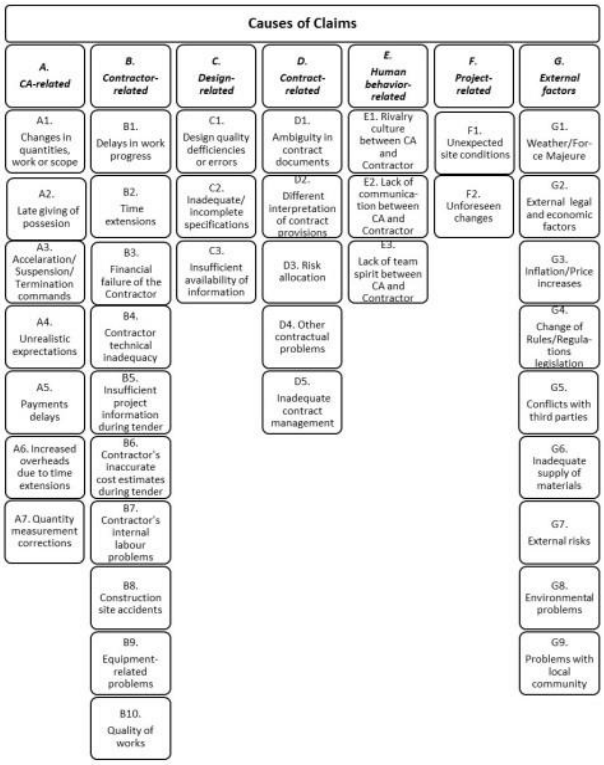
Henry Ajaelu et al (2020) conducted a study that reveals a significant barrier to the adoption of arbitration in Nigeria's construction industry: the general lack of awareness regarding its existence and benefits, particularly within the informal sector. The research used a mixed-method approach, collecting primary data through questionnaires distributed to 100 respondents from various construction-related organizations, along with secondary data from existing literature. The findings show that arbitration is seen as a more cost-effective and time-efficient method of dispute resolution compared to litigation, with mean satisfaction scores of 4.56 and 4.68 for cost and time, respectively, while litigation received lower scores. The study underscores the effectiveness of arbitration in resolving construction disputes, promoting sustainable relationships between parties, and suggests that enhancing awareness and education about arbitration could lead to its wider use in the industry.[28]

Anjay Kumar Mishra et al (2022) highlights the critical role of arbitration as an alternative dispute resolution (ADR) mechanism in Nepalese road construction contracts, revealing a concerning success rate of only 21.43% in resolving disputes. This low acceptance of arbitrators' decisions, particularly from employers, significantly hampers project efficiency, leading to cost overruns, delays, and quality degradation. The study utilized a mixed-methods approach, gathering both qualitative and quantitative data through literature reviews, case studies, and a questionnaire survey targeting contractors and employers involved in disputes. The findings show a stark contrast in perceptions between employers, who often view arbitration as ineffective, and contractors, who generally favor it. This disparity suggests a need for improved trust and mechanisms to enhance the arbitration process. The research ultimately calls for a reevaluation of arbitration practices to foster better acceptance and effectiveness, promoting timely project delivery and efficient public spending in the construction sector.[29]

Amila Gamage et al (2024) comprehensively examines the efficacy of Alternative Dispute Resolution (ADR) mechanisms in the construction industry, emphasizing their critical role in mitigating disputes that arise from the complex and dynamic nature of construction projects. The study identifies various ADR techniques, including mediation, arbitration, negotiation, and adjudication, and evaluates their advantages and limitations compared to traditional litigation, highlighting benefits such as time and cost savings, confidentiality, and the preservation of relationships among stakeholders. Using a systematic literature review approach, the authors analyzed relevant articles to gather insights on the applicability of these ADR methods, ultimately recommending strategic management tools like SWOT and PESTLE analyses to help project leaders select the most suitable ADR strategy based on specific dispute contexts. The findings underscore the necessity for efficient dispute resolution mechanisms to enhance project performance and success, advocating for further empirical research to validate and refine these ADR approaches in real-world scenarios.[30]

Marianna Kalogeraki et al presents (2024) a comprehensive bibliometric analysis and content review of 27 studies on claim management and dispute resolution in the construction industry, revealing key trends and insights into the factors that lead to claims and disputes. Using the PRISMA methodology, the authors analyzed 231 journal articles and conference papers published between 2020 and 2022, identifying six primary research themes. A significant focus was placed on contract-related causes of claims, which were covered in 79 studies. The findings emphasize the critical role of contract factors in construction disputes and

highlight the growing impact of technologies such as Building Information Modeling (BIM), blockchain, and smart contracts in improving claim management processes. This study not only reflects the increasing academic interest in this area, with 341 publications in the last five years, but also paves the way for future research on optimizing construction contracts and leveraging technology to reduce disputes.[31]



Wesam Alaloul et al (2019) provides a comprehensive analysis of dispute resolution methods in construction projects, emphasizing the importance of effective strategies to reduce the adversarial nature of contractual relationships. The paper compares traditional methods like litigation with Alternative Dispute Resolution (ADR) techniques such as mediation, arbitration, and dispute review boards, outlining their respective advantages and disadvantages based on the dispute context. The findings highlight that no single method fits all situations, but a proactive approach involving early conflict identification and clear communication can significantly reduce dispute escalation. The authors recommend incorporating flexible dispute resolution clauses in contracts, allowing parties to adjust their approach as disputes arise, which fosters a more collaborative environment and improves the success rate in resolving conflicts, as demonstrated by the 98% success rate of Dispute Review Boards.[32]

Allan Abwunza et al (2020) focuses on identifying and analyzing the causes of delays in construction arbitration, particularly in Kenya, using a qualitative case study approach. The study examined five case examples drawn from court judgments, with data collected through in-depth interviews with arbitrators, parties, and their representatives, alongside documentary analysis. The findings revealed that delays were often caused by issues such as non-compliance with deadlines, reluctance to provide necessary evidence, and procedural inefficiencies. The study emphasizes the need for improved procedural controls and greater stakeholder engagement to reduce delays and enhance the effectiveness of construction arbitration in Kenya, which could also inform broader practices in the field.

Mante, j. et al (2018) critically examines the resolution of disputes arising from major infrastructure projects in developing countries, focusing on international commercial arbitration (ICA) as the predominant mechanism for dispute resolution. The study highlights a significant gap in the literature regarding the processes involved in these disputes and the dynamics between their emergence and the initiation of formal arbitration. Using a qualitative research approach, the study explores the complexities of dispute resolution in a developing country through case studies, aiming to provide insights into the challenges faced by local parties who are often at a disadvantage in arbitration. The findings emphasize the need for effective early dispute resolution mechanisms and suggest that alternative dispute resolution (ADR) methods, increasingly utilized in developed countries, should be explored and implemented in developing contexts to improve the efficiency and cost-effectiveness of resolving construction disputes, ultimately aiding infrastructure development and poverty alleviation efforts.[33]

Harisankar K.S. et al (2013) highlights the need for a better way to solve disputes in public-private partnerships (PPPs) for infrastructure projects in India, to attract more private investment. The study points out problems with the current system, like long and complicated court cases, which make arbitration less effective. The authors suggest creating a system that combines friendly settlement, mediation, and adjudication by specialized bodies to speed up the process and reduce court involvement. By looking at different laws in India, the paper proposes a new model that focuses on experts and reduces the role of civil courts. The study shows that these changes could improve how disputes are solved and encourage more private sector investment in infrastructure projects.[34]

VI. CHALLENGES AND LIMITATIONS.

1. Clarity of Terms: Contracts should be clear, detailing responsibilities, conditions for extensions of time (EoT), and how delays will be handled to avoid misunderstandings.
2. Inclusion of Provisions: Essential clauses like force majeure, change orders, and dispute resolution should be included to cover unexpected events and ensure fairness.
3. Documentation Requirements: Contracts must specify what documents are needed for claims and delays, such as notice periods and supporting evidence, to ensure accountability and smooth management of issues.
4. Unpredictable External Factors: External events like bad weather or political changes can cause delays that are hard to control or predict.
5. Site-Specific Issues: Unique site conditions, such as poor soil or access problems, can delay progress and complicate delay analysis.

6. Inconsistent Record-Keeping: Poor or inconsistent documentation of delays makes it difficult to analyze and resolve issues effectively.
7. Lack of Standardized Delay Analysis Methods: Different methods of delay analysis can lead to confusion and disagreements about delay causes and responsibility.
8. Contractual Ambiguities: Unclear contract terms related to delays can lead to disputes over entitlements and consequences.
9. Poor Communication Among Stakeholders: Lack of effective communication between parties can escalate conflicts and delay resolution.
10. Cultural and Regional Differences: Differences in culture or legal practices, especially in international projects, can complicate dispute resolution.
11. Lack of Timely Resolution Mechanisms: Delays in resolving disputes through arbitration or mediation can prolong project timelines and increase costs.
12. Ineffective Dispute Resolution Framework: Without a clear and efficient process, disputes can become prolonged and costly, affecting project outcomes.
13. Resistance to Collaborative Solutions: Some parties may resist negotiating or finding common ground, which can make resolving disputes more challenging.
14. Complexity of the Dispute: Disputes involving multiple parties, complex claims, or technical issues are harder to resolve quickly and efficiently.

VII. CONCLUSION

Construction projects are often complicated and can face delays, which affect both timelines and costs. Proper delay management is very important, and contracts play a key role by defining responsibilities and solutions like Extension of Time (EoT) clauses and penalties to handle financial risks. Techniques such as Time Impact Analysis (TIA) and Relative Importance Index (RII) help understand the reasons for delays, assign responsibility, and resolve disputes fairly. However, unclear contract terms, poor record-keeping, and inconsistent methods can make resolving disputes harder and lead to longer conflicts. Clear documentation, better communication among all parties, and using consistent delay analysis methods are essential to reduce such problems. Technologies like AI and Building Information Modeling (BIM) also offer new ways to improve delay management and make contract terms more effective. A strong contract structure, combined with good delay management and dispute resolution strategies, helps reduce conflicts and ensures construction projects are completed successfully.

REFERENCE

[1] O. P. Giri, "Perception-Based Assessment of the Factors Causing Delays in Construction Projects," *Engineering*, vol. 15, no. 07, pp. 431–445, 2023, doi: 10.4236/eng.2023.157033.

[2] "Making claims for time and money." [Online]. Available: www.fenwickelliott.co.uk

[3] W. Herroelen and R. Leus, "Robust and reactive project scheduling: A review and classification of procedures," Apr. 15, 2004. doi: 10.1080/00207540310001638055.

[4] A. I. Eldosouky, T. M. Elkorany, and K. A. Albayomi, "Development of ECC for infrastructure projects," *Ain Shams Engineering Journal*, vol. 14, no. 9, Sep. 2023, doi: 10.1016/j.asej.2022.102064.

[5] R. S. Al-Sabah and S. S. Al-enezi, "Reducing contract disputes: A comparative analysis of FIDIC and GCC standard general conditions of contract for construction projects," *Journal of Engineering Research*, Oct. 2024, doi: 10.1016/j.jer.2024.09.015.

[6] D. Mohamed Abdel-Hamid and A. R. Alaa El-Din Mostafa, "The Effect of FIDIC red book 2017 to avoid disputes in Egyptian construction field," May 01, 2023, *Ain Shams University*. doi: 10.1016/j.asej.2022.101963.

[7] B. Saad Alotaibi *et al.*, "Building information modeling (BIM) adoption for enhanced legal and contractual management in construction projects," *Ain Shams Engineering Journal*, vol. 15, no. 7, Jul. 2024, doi: 10.1016/j.asej.2024.102822.

[8] I. Ndekugri, "Late disputes and the NEC3 Engineering and Construction Contract," *Proceedings of Institution of Civil Engineers: Management, Procurement and Law*, vol. 169, no. 2, pp. 65–76, Feb. 2016, doi: 10.1680/jmapl.15.00037.

[9] A. M. Tawfek and D. K. Bera, "Delay in Construction Projects: Types, Causes and Effects," 2018. [Online]. Available: https://www.researchgate.net/publication/365322620

[10] S. A. Assaf and S. Al-Hejji, "Causes of delay in large construction projects," *International Journal of Project Management*, vol. 24, no. 4, pp. 349–357, May 2006, doi: 10.1016/j.ijproman.2005.11.010.

[11] G. Mejía, O. Sánchez, K. Castañeda, and E. Pellicer, "Delay causes in road infrastructure projects in developing countries", doi: 10.7764/RDLC.19.2.220.

[12] T. Gebrehiwet and H. Luo, "Analysis of Delay Impact on Construction Project Based on RII and Correlation Coefficient: Empirical Study," in *Procedia Engineering*, Elsevier Ltd, 2017, pp. 366–374. doi: 10.1016/j.proeng.2017.07.212.

[13] A. A. Fashina, M. A. Omar, A. A. Sheikh, and F. F. Fakunle, "Exploring the significant factors that influence delays in construction projects in Hargeisa," *Heliyon*, vol. 7, no. 4, Apr. 2021, doi: 10.1016/j.heliyon.2021.e06826.

[14] H. S. Ahmad, M. D. Ayoush, and M. S. Al-Alwan, "Causes of delay to public infrastructure projects according to engineers representing different contract parties," *Built Environment Project and*

Asset Management, vol. 10, no. 1, pp. 153–179, Feb. 2020, doi: 10.1108/BEPAM-03-2019-0026.

[15] S. K. Patil, A. K. Gupta, D. B. Desai, and A. S. Sajane, "CAUSES OF DELAY IN INDIAN TRANSPORTATION INFRASTRUCTURE PROJECTS." [Online]. Available: http://www.ijret.org

[16] H. A. Orban and O. Hosny, "Delay Analysis Techniques in Construction Projects," 2018. [Online]. Available: https://www.researchgate.net/publication/330764118

[17] A. Wasfy and A. Nassar, "Delay Analysis Statements in the Presence of Debatable Concerns in Construction Projects," *IEEE Engineering Management Review*, vol. 49, no. 4, pp. 123–135, 2021, doi: 10.1109/EMR.2021.3121510.

[18] A. Sherif, A. M. Abdelalim, and A. M. Abdelalim, "Delay Analysis Techniques and Claim Assessment in Construction Projects," *International Journal of Management and Commerce Innovations*, vol. 10, pp. 316–325, 2022, doi: 10.5281/zenodo.7509156.

[19] W. A. Paray and C. Kumar, "DELAY ANALYSIS IN CONSTRUCTION PROJECTS," *International Research Journal of Engineering and Technology*, 2020, [Online]. Available: www.irjet.net

[20] S. Singh, "Detail Study of Delay Analysis in Construction Projects due to Multiple Factors Using RII Method," 2021, doi: 10.37421/2165-784X.2022.12.458.

[21] A. Vasilyeva-Lyulina, M. Onishi, and K. Kobayashi, "Delay Analysis Methods for Construction Projects: Mathematical Modelling," *International Journal of Transportation*, vol. 3, no. 1, pp. 27–36, Apr. 2015, doi: 10.14257/ijt.2015.3.1.03.

[22] J. Bin Yang and C. K. Kao, "Critical path effect based delay analysis method for construction projects," *International Journal of Project Management*, vol. 30, no. 3, pp. 385–397, Apr. 2012, doi: 10.1016/j.ijproman.2011.06.003.

[23] H. Y. Chong and R. M. Zin, "Selection of dispute resolution methods: Factor analysis approach," *Engineering, Construction and Architectural Management*, vol. 19, no. 4, pp. 428–443, 2012, doi: 10.1108/09699981211237120.

[24] S. Safinia, "A Review on Dispute Resolution Methods in UK Construction Industry," *International Journal of Construction Engineering and Management*, vol. 3, no. 4, pp. 105–108, 2014, doi: 10.5923/j.ijcem.20140304.01.

[25] S.-O. Cheung, ; Henry, C. H. Suen, and T.-I. Lam, "Fundamentals of Alternative Dispute Resolution Processes in Construction", doi: 10.1061/ASCE0733-93642002128:5409.

[26] J. R. Cheeks and M. Asce, "Multistep Dispute Resolution in Design and Construction Industry", doi: 10.1061/ASCE1052-39282003129:284.

[27] B. B. Thomas Treacy, "USE OF ALTERNATIVE DISPUTE RESOLUTION IN THE CONSTRUCTION INDUSTRY."

[28] A. Henry* and R. Okereke, "Arbitration as an Alternative to Litigation in Construction Projects," *International Journal of Management and Humanities*, vol. 4, no. 9, pp. 166–172, May 2020, doi: 10.35940/ijmh.I0860.054920.

[29] A. K. Mishra and P. S. Aithal, "Effectiveness of Arbitration in Construction Projects," *International Journal of Management, Technology, and Social Sciences*, pp. 96–111, Feb. 2022, doi: 10.47992/ijmts.2581.6012.0180.

[30] A. N. K. K. Gamage and S. Kumar, "Review of Alternative Dispute Resolution Methods in Construction Projects," *Saudi Journal of Engineering and Technology*, vol. 9, no. 02, pp. 75–87, Feb. 2024, doi: 10.36348/sjet.2024.v09i02.007.

[31] M. Kalogeraki and F. Antoniou, "Claim Management and Dispute Resolution in the Construction Industry: Current Research Trends Using Novel Technologies," *Buildings*, vol. 14, no. 4, Apr. 2024, doi: 10.3390/buildings14040967.

[32] W. S. Alaloul, M. W. Hasaniyah, and B. A. Tayeh, "A comprehensive review of disputes prevention and resolution in construction projects," *MATEC Web of Conferences*, vol. 270, p. 05012, 2019, doi: 10.1051/matecconf/201927005012.

[33] A. A. Abwunza, T. K. Peter, and K. Muigua, "Explaining Delays in Construction Arbitration: A Process-Control Model Approach," *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, vol. 12, no. 2, May 2020, doi: 10.1061/(asce)la.1943-4170.0000371.

[34] H. K.S. and S. G., "Rethinking Dispute Resolution in Public–Private Partnerships for Infrastructure Development in India," *Journal of Infrastructure Development*, vol. 5, no. 1, pp. 21–32, Jun. 2013, doi: 10.1177/0974930613488292.