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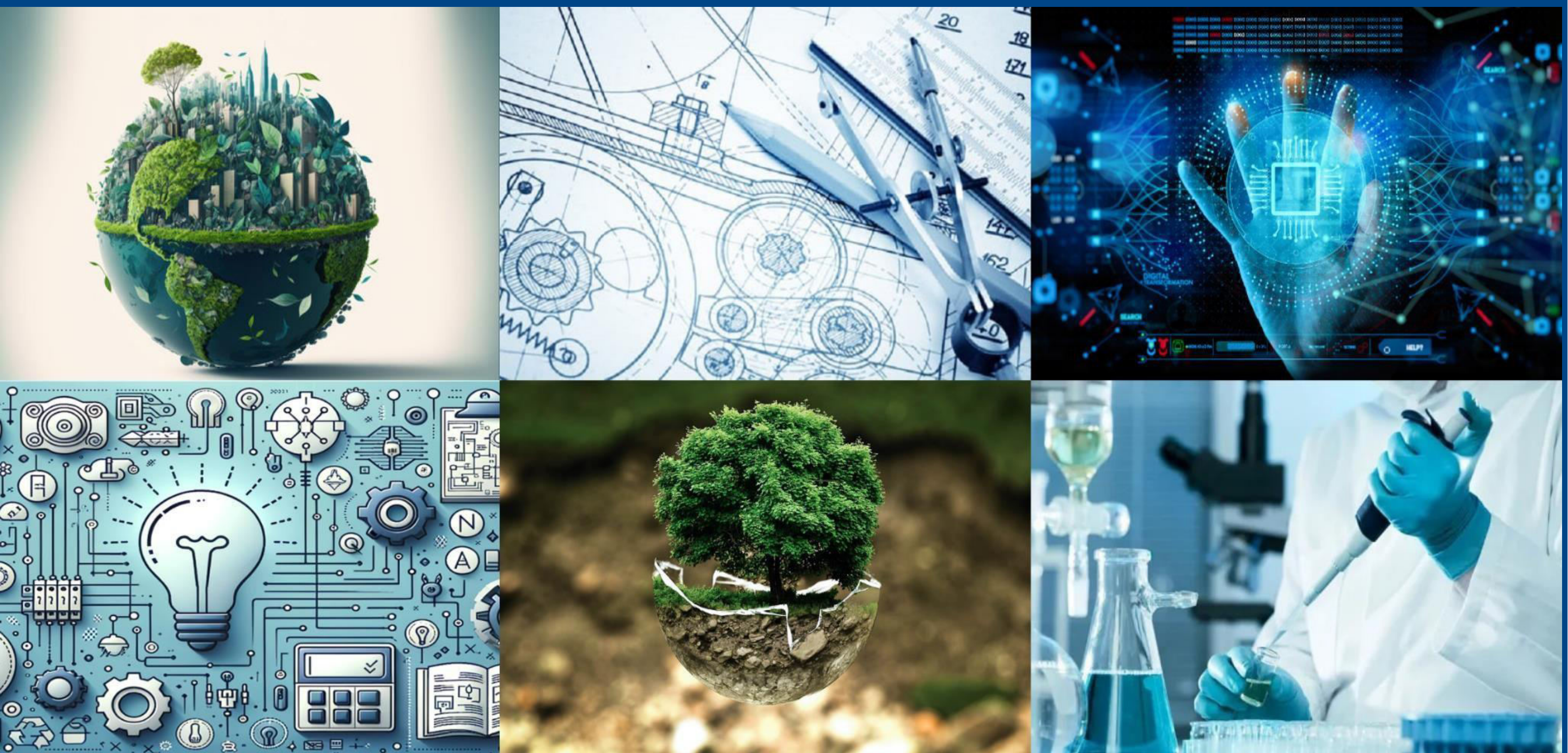

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Time Impact Analysis (TIA) Window Analysis with a Case Study

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ABSTRACT: Construction projects often face delays due to complex interconnections, unexpected events, and poor planning. These delays lead to requests for more time (called extensions of time or EOT) and extra costs (known as prolongation costs). Dealing with prolongation cost claims is one of the trickiest parts of managing construction contracts because it directly affects how much money the project makes and how cash flows. Contractors frequently run into problems like design issues and change orders. This research aims to create a clear, step-by-step approach for spotting, evaluating, and prolongation cost claims related to EOT. It focuses on standard contract types, especially those based on FIDIC agreements. The researchers looked at existing studies, real-world cases, and created theoretical models. From this, they suggest a standard method that combines ways to analyze delays, assess cost impacts, and meet documentation requirements. The study emphasizes how important it is to keep accurate, real-time records, use fair methods to analyze delays, and pay attention to specific contract terms when making claims. These findings should help improve how claims are managed and make it easier to fairly settle disputes about time and money in construction projects.

KEYWORDS: Extension of Time (EOT), Prolongation Cost, Delay Analysis, Construction Claims, FIDIC Contracts, Project Management

I. INTRODUCTION

The construction industry faces numerous challenges and risks that can cause project delays. When these delays are deemed excusable, contractors may be granted an Extension of Time (EOT). However, delays often lead to significant financial consequences, particularly in the form of prolongation costs - additional expenses that arise from the extended project duration. Assessing prolongation cost claims is often a contentious process, as it's difficult to establish causation, entitlement, and quantification.

Research by Alnuaimi and Mohsin (2022) highlights the significance of this issue, revealing that delay claims make up over 30% of disputes in major infrastructure projects. This underscores the critical need for effective management of prolongation claims to ensure contractual fairness and reduce financial losses.

This paper delves into the fundamental principles of EOT and prolongation cost claims. It examines current methodologies for evaluating delays and associated costs and puts forward an integrated framework for industry professionals to use in practice.

II. LITERATURE REVIEW

2.1 Evolution of Delay Analysis Techniques

Over the years, delay analysis in construction has come a long way. Initially, simple methods like comparing the original plan to the actual results—known as As-Planned vs As-Built—were used. However, as projects became more complex, experts developed more advanced approaches to understand and resolve delays. The main types you'll often see include:

- As-Planned vs As-Built (Total Time Analysis)
- Collapsed As-Built / But-For Analysis
- Impacted As-Planned Analysis

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- Time Impact Analysis (TIA)
- Window Analysis (either looking back or in real time)

Of all these methods, TIA stands out because it helps predict the effects of delays before they happen and uses logical analysis to show how the project's critical path changes.

2.2 Evolution of Delay Analysis Techniques

The SCL Protocol 2017 defines TIA as a method suitable for both prospective and retrospective contexts. When used contemporaneously, it is prospective projecting likely impacts before they occur. When used retrospectively, it becomes forensic, analyzing the actual impact of past events. The Protocol emphasizes maintaining auditable logic, accurate data inputs, and transparent assumptions to ensure credibility before tribunals or dispute boards.

2.3 FIDIC 2017 Red Book Perspective

Under FIDIC 2017, Sub-Clause 8.4 (Extension of Time for Completion) requires the Engineer to assess the delay "as soon as practicable" after the Contractor provides substantiation. The clause encourages contemporaneous assessment, making TIA the most compliant technique since it models each event within the schedule contemporaneously or in reconstructed updates.

2.4 Advantages of Window Analysis

According to Pickavance (2010) and Hegazy (2016), window analysis makes project assessments more dependable because it captures actual project conditions as they happen, tracks changes in the critical path as work progresses, considers both mitigation and acceleration measures, and clearly separates delays caused by the employer from those caused by the contractor.

III. METHODOLOGY

3.1 Conceptual Framework

The Window-Based TIA combines the real-time updating style of window analysis with the detailed modeling of TIA. In this method, the project is divided into defined periods—often by month or by project phase. For each window, the progress made so far (as-built progress) is updated, any delay events that occurred are identified and analyzed, and the resulting change in project completion is tracked. The conceptual flow of window-based TIA is shown in Fig.1 below.

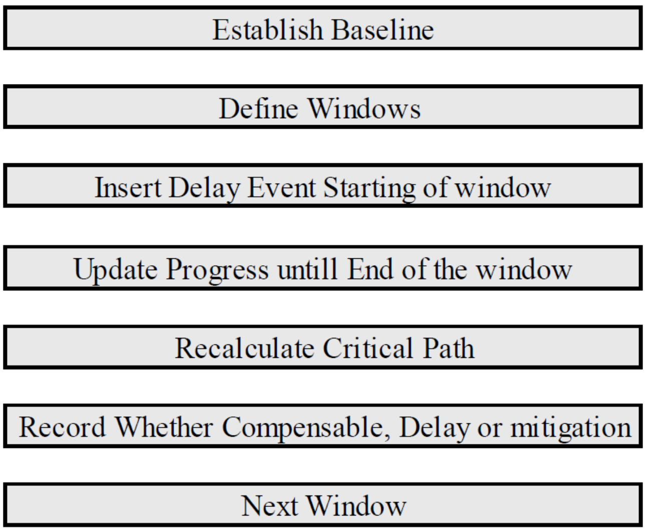

Fig. 1 Conceptual Flow of Window Based TIA

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3.2 Data Sources

The data sources used for the Time Impact Analysis include several key documents and records. These consist of the Primavera P6 baseline schedules and their subsequent updates, which help track planned versus actual progress. Site progress reports provide regular updates on construction activities and milestones. Correspondence, such as the Engineer's Letters, Requests for Information (RFIs), and approvals for variations (VOs), offer insight into project communications and changes. Additionally, daily progress photographs and weather records capture on-site conditions and any environmental factors affecting the work. Finally, contract clauses and variation logs detail the contractual framework and any officially recorded changes, ensuring all relevant information is considered in the analysis.

IV. CASE STUDY

4.1 Project Overview

The subject project is a municipal infrastructure development comprising road networks, drainage lines, and utilities.
- Contract Duration: 540 days
- Contract Type: FIDIC Red Book 2017
- Contract Value: SAR 185 million
- Planner Tool: Primavera P6 Version 22

4.2 Identified Delay Events

The identified delay event till the window analysis cut of date is shown in the below Table.1

Event No.	Description	Type	Duration (Days)	Responsibility
1	Late approval of IFC Drawings	Excusable, Compensable	25	Employer
2	Site access restriction by Municipality	Excusable, Compensable	40	Employer
3	Utility diversion (additional scope)	Excusable, Compensable	30	Employer

Table 1 Delay Events

4.3 Window Segmentation

The window segmentation for the window analysis is shown in the below Table.2 in each window at the starting of the window the delay events are inserted and at updated to the end of the window.

Window	Period	Major Events	Cumulative Delay (Days)	Remarks
1	Month 1–2	Mobilization & baseline setup	0	On track
2	Month 3–4	IFC drawings delayed	+18	First slippage observed
3	Month 5–6	Site access restriction	+30	Critical path shifted
4	Month 7–8	Utility diversion	+25	VO-related delay
5	Month 9–10	Acceleration & mitigation	−10	Partial recovery

Table 2 Window Segmentation

4.4 TIA Simulation Results

- Using Primavera P6 The cumulative delay to the project completion date was 63 days.
- Mitigation through overtime and resequencing recovered 10 days.
- Revised completion = 603 days (vs 540 original).
- Engineer granted EOT = 63 days under FIDIC 8.4.

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V. ANALYSIS AND DISCUSSION

5.1 Accuracy and Transparency

The window-based TIA demonstrated superior traceability compared to a global "As-Built vs As-Planned" approach. Each delay's incremental effect was identifiable, and schedule logic adjustments were documented contemporaneously.

5.2 Accuracy and Transparency

During Window 3, a short-term equipment breakdown overlapped with the employer's site access restriction. Applying SCL 11.3 guidance, the concurrent contractor delay was deemed non-critical, as it did not affect the dominant critical path. Hence, the EOT entitlement remained full for the employer-related delay.

5.3 Contractual Evaluation

Under FIDIC Clause 8.4, the Engineer must grant extension where delay is not attributable to the Contractor. The TIA substantiated entitlement through clear evidence of cause–effect linkage between employer events and critical path slippage. Additionally, Sub-Clause 20.2 (Claims) requirements—notice, particulars, and substantiation—were satisfied through periodic submissions supported by updated P6 schedules.

5.4 Lessons on Data Discipline

The effectiveness of TIA depends on Timely baseline updates.
- Verified actual progress data (quantities, % complete).
- Traceable logic in schedules.

Without these, the analysis risks becoming subjective and unconvincing before dispute adjudication boards or arbitration tribunals.

5.5 Comparative Evaluation

A comparison of window-based TIA and single point TIA is given below in Table.3 for window based it will require of more schedule analysis and accuracy will be high and transparency to the concurrency will be high. For single point analysis the accuracy will be less compared to the window analysis.

Criteria	Single Point / Non periodic	Window Based
Snapshot Frequency	One-time	Multiple windows
Accuracy	Moderate	High
Ability to Reflect Mitigation	Limited	Excellent
Transparency	Medium	High
Suitability for Arbitration	Moderate	Strong

Table 3 Comparison of Window Based and Single point analysis

5.6 Prolongation Cost implications

Using the verified EOT, site overhead prolongation cost was computed at SAR 42,000/day (take from actual cost data) × 63 days = SAR 2.646 million, excluding head-office overhead. The TIA results thus directly informed the Prolongation Cost Claim.

For head office overhead claim rather than using the formulas the best practice is to check the actual cost incurred and the percentage allocation of head office to the project and arrive in the cost per day and by multiplying to the approved EOT that is 63 days we will get the head office overhead cost.

VI. PRACTICAL RECOMMENDATIONS

To ensure effective delay analysis and minimize disputes in construction projects, it is essential to maintain contemporaneous records throughout the project's duration. Practitioners should also integrate cost and time analysis, allowing for a comprehensive understanding of the financial and scheduling implications of delays. Adopting a rollingwindow approach enhances the ability to capture evolving delay causation and respond proactively. Additionally, training planning engineers in the creation of fragnets and float management is crucial for accurate modeling of schedule impacts. Finally, encouraging the early acceptance of Time Impact Analysis (TIA) submissions helps to address potential disagreements promptly and supports smoother project administration.

VII. CONCLUSION

The Window-Based Time Impact Analysis technique enhances the fairness and defensibility of extension-of-time assessments in complex projects. The case study demonstrates its practical superiority in identifying evolving delay causation, validating entitlement, and integrating mitigation measures. When aligned with SCL Protocol 2017 and FIDIC Red Book 2017, it provides a transparent and technically rigorous foundation for delay and cost claims, supporting equitable contract administration and reducing post-completion disputes.

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