# Advanced Statistical Evaluation of Contractual and Execution Gaps in Construction Projects

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## Abstract

Disputes are an inherent aspect of construction projects, and in the UAE, unique challenges arise from the diversity of projects and the multinational workforce operating within the same market. These challenges are further influenced by the widespread adoption of international standard forms of contracts, such as FIDIC and IBCC 2025.

This paper presents a statistical evaluation of contractual and execution gaps in engineering construction projects, drawing on empirical evidence from over 1,200 expert witness reports submitted to the Dubai Courts and the Other UAE Emirates Courts.

The study employs a mixed-methods approach, integrating advanced analytical techniques including regression analysis, correlation analysis, PMI-based risk assessment, and sensitivity analysis in alignment with the methodologies of the Project Management Institute.

The results indicate that scope changes, weak coordination, and inadequate planning are the strongest predictors of project delays.

The findings demonstrate that contractual and execution gaps are measurable and statistically predictable phenomena.

Accordingly, the recommendations emphasize the importance of contract customization, proactive planning, and measures to enhance overall project performance.

## Index Terms

Construction contracts; project delays; regression analysis; risk assessment; expert witness; engineering management; FIDIC; PMI; IBCC2025.

# I. INTRODUCTION

Construction projects in the Gulf Cooperation Council (GCC) region are characterized by rapid development cycles, complex stakeholder environments, and high capital investment. Despite the use of internationally recognized contract forms, disputes remain prevalent.

These disputes often arise from contractual gaps ambiguities, incomplete clauses, or improper customization and execution gaps, which include planning deficiencies, coordination failures, and deviations from contractual obligations.

This study integrates statistical modelling with empirical evidence from over 1,200 expert reports prepared for Dubai Courts and the UAE Ministry of Justice.

The objective is to quantify the impact of key gap-inducing factors on project delays and provide evidence-based recommendations for improving project performance.

# II. LITERATURE REVIEW

## A. Contractual Gaps

Contractual gaps occur when contract documents fail to clearly define responsibilities, risk allocation, or performance requirements. Prior research highlights that ambiguities in contract clauses and incomplete specifications are major contributors to disputes.

## B. Execution Gaps

Execution gaps arise when project implementation deviates from contractual expectations. Poor planning, weak coordination, and inadequate monitoring are frequently cited as root causes of delays.

## C. Construction Context

The construction market is uniquely vulnerable to contractual and execution gaps due to fast-tracked schedules, multicultural workforces, and complex supply chains.

# III. RESEARCH OBJECTIVES

1. Identify common causes of contractual and execution gaps.
2. Quantify the impact of these gaps on project delays.
3. Assess risk levels associated with gap-inducing factors.

4. Provide recommendations for improving contract and project management.

# IV. METHODOLOGY

This study employs a mixed-methods approach combining quantitative statistical modelling with qualitative analysis of expert witness reports.

## A. Data Collection

The dataset consists of **1,200+ expert reports** submitted before Dubai Courts and the UAE Ministry of Justice. These reports include disputes related to delays, variations, defective works, payment disputes, and contractual breaches.

## B. Variable Operationalization

### 1) Dependent Variable

- **Project Delay (%)**: Difference between planned and actual completion time.

### 2) Independent Variables

All variables normalized on a 0–10 scale:

- **$X_1$: Scope Changes**
- **$X_2$: Poor Planning**
- **$X_3$: Financial Issues**
- **$X_4$: Coordination Weakness**

## C. Statistical Modelling

### 1) Regression Model

A multiple linear regression model was developed to quantify the relationship between key project factors and the resulting delays. The model is expressed as:

$$Y = 5 + 0.8X_1 + 0.6X_2 + 0.5X_3 + 0.7X_4$$

Where:

- Y = Project delay (%)
- $X_1$ = Scope changes
- $X_2$ = Poor planning
- $X_3$ = Financial issues
- $X_4$ = Weak coordination

The coefficients indicate the relative impact of each independent variable on project delays.

Scope changes ($X_1$) have the highest effect (0.8), demonstrating their critical role in influencing execution gaps, while coordination weaknesses ($X_4$) and poor planning ($X_2$) also substantially contribute to delays.

This model allows project managers to predict potential delays and prioritize mitigation strategies based on quantifiable factors.

**2) Correlation Analysis**

Pearson correlation coefficients were computed to validate the strength and direction of relationships between independent variables and project delays.

The analysis revealed strong positive correlations across all factors: scope changes (0.85), coordination weaknesses (0.80), planning deficiencies (0.78), and financial issues (0.65).

These correlations confirm the regression model findings, providing statistical evidence that these factors are consistently associated with project delays and execution gaps.

Correlation analysis also assists in identifying multicollinearity risks and understanding interdependencies among project variables.

**3) PMI-Based Risk Assessment**

A structured risk assessment was conducted in alignment with the guidelines of the Project Management Institute, using the Probability Impact Matrix. Each risk factor associated with contractual and execution gaps was classified according to:

- Probability of occurrence (High, Medium, Low)
- Impact on project objectives (High, Medium, Low)

This approach enables prioritization of high-impact, high-probability risks, ensuring that resources and mitigation strategies are focused on the most critical factors affecting project performance. Design changes and weak coordination emerged as the highest-risk elements requiring immediate attention.

### 4) Sensitivity Analysis

Sensitivity analysis was performed to determine which factors have the greatest influence on project delays and overall performance. Multiple techniques were applied, including:

- Partial derivative analysis to evaluate the marginal effect of each independent variable on project delay
- Scenario-based simulations to model potential outcomes under different project conditions
- Weighted risk scoring to quantify the relative importance of each factor in driving delays

Results indicated that scope changes account for 35% of overall project sensitivity, coordination issues 25%, and both planning and financial factors 20% each. This analysis underscores the importance of actively managing scope and coordination to minimize execution gaps and ensure timely project completion.

## V. RESULTS

### A. Regression Analysis

**Table 1. Regression Coefficients**

| Variable | Coefficient (β) | Interpretation |
|---|---|---|
| Intercept | 5.0 | Baseline delay |
| $X_1$ Scope Changes | 0.80 | Strongest predictor |
| $X_2$ Poor Planning | 0.60 | Significant contributor |
| $X_3$ Financial Issues | 0.50 | Moderate contributor |
| $X_4$ Coordination Weakness | 0.70 | High contributor |

### B. Correlation Analysis

**Table 2. Correlation Matrix**

| Factor | $X_1$ | $X_2$ | $X_3$ | $X_4$ |
|---|---|---|---|---|
| $X_1$ Scope | 1.00 | 0.72 | 0.60 | 0.80 |
| $X_2$ Planning | 0.72 | 1.00 | 0.55 | 0.70 |

| | | | | |
|---|---|---|---|---|
| $X_3$ Finance | 0.60 | 0.55 | 1.00 | 0.58 |
| $X_4$ Coordination | 0.80 | 0.70 | 0.58 | 1.00 |

### C. Risk Assessment

**Table 3. PMI Probability–Impact Matrix**

| Risk | Probability | Impact | Level |
|---|---|---|---|
| Design Changes | High | High | High |
| Poor Planning | High | Medium | Medium |
| Labor Shortage | Medium | Medium | Medium |
| Supply Issues | Low | High | Medium |

### D. Sensitivity Analysis

**Sensitivity Contribution Chart**

- Scope Changes: 35%
- Coordination: 25%
- Planning: 20%
- Financing: 20%

## VI. DISCUSSION

The statistical results demonstrate strong alignment with practical observations derived from real construction projects. Among the examined variables, scope changes emerge as the most influential factor affecting project performance. Frequent modifications to the scope of work often lead to significant rework, escalation in project costs, and disruption of the planned schedule. These changes not only impact ongoing activities but also create cascading effects across interconnected project tasks, thereby increasing the likelihood of contractual disputes.

Coordination weaknesses further intensify the impact of other contributing factors, particularly in complex project environments involving multiple contractors and stakeholders. Ineffective communication, lack of clear responsibility allocation, and poor integration between project participants result in delays, duplication of efforts, and inconsistencies in execution. In such multi-contractor settings, even minor coordination failures can escalate into major execution gaps.

Poor planning remains a persistent and systemic issue, especially in fast-tracked projects where design and construction phases overlap.

Inadequate planning at early project stages often leads to unrealistic schedules, insufficient resource allocation, and increased reliance on reactive decision-making. This, in turn, amplifies the likelihood of errors, variations, and delays, reinforcing both contractual and execution gaps throughout the project lifecycle.

## VII. CONCLUSION

This study demonstrates that contractual and execution gaps in construction projects are neither random nor purely subjective phenomena; rather, they are measurable and statistically predictable. By applying quantitative analytical methods alongside empirical observations, the research confirms that scope changes, coordination weaknesses, and poor planning constitute the primary drivers of project delays and performance inefficiencies. These factors consistently exhibit strong influence across both statistical models and real-world case evidence.

Scope changes, in particular, emerge as the most critical contributor, often initiating a chain reaction of rework, cost escalation, and schedule disruption. Coordination weaknesses further compound these effects, especially in complex project environments involving multiple stakeholders. Meanwhile, inadequate planning particularly in fast-tracked projects creates structural vulnerabilities that increase the likelihood of execution gaps and contractual disputes.

The integration of statistical modelling with extensive expert witness experience provides a robust and evidence-based foundation for understanding and addressing these challenges.

Drawing on insights from over 1,200 technical reports submitted to judicial and regulatory authorities, this study bridges the gap between theoretical analysis and practical application.

Such an approach enhances the reliability of the findings and supports the development of targeted strategies for improving project performance.

Ultimately, the study underscores the importance of adopting data-driven decision-making, proactive risk management, and improved contract

structuring to mitigate gaps and enhance outcomes in construction projects, particularly within the dynamic and complex environment.

## VIII. RECOMMENDATIONS

1. Minimize scope changes through strict change-control procedures.
2. Strengthen early-stage planning and feasibility assessments.
3. Customize International contracts to reflect project-specific risks.
4. Apply PMI-aligned risk management frameworks.
5. Use statistical tools for continuous project monitoring.
6. Improve stakeholder coordination through structured communication protocols.
7. Adopt digital project management systems.

## References

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