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FACTORS AFFECTING COST OVERRUNS AND DELAYS IN PHILIPPINE CONSTRUCTION PROJECTS: BASIS FOR AN IMPROVED PROJECT MANAGEMENT FRAMEWORK

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Abstract

Budgetary expansion and timeline slippage represent endemic structural challenges in public and private infrastructure delivery across developing nations, undermining macroeconomic productivity and public financial efficacy. This investigation evaluates the structural determinants driving project delays and cost escalations in the Philippine construction sector to formulate an evidence-based, adaptive project management framework. Using an explanatory cross-sectional quantitative research design, empirical data were collected from 384 key industry stakeholders—including public project owners, main contractors, and engineering consultants—operating across major Philippine administrative regions, including Metro Manila, Central Luzon, CALABARZON, Northern Mindanao, and BARMM. Quantitative evaluation employed the Relative Importance Index (RII) ranking, Pearson product-moment correlation, Multiple Linear Regression, One-Way Analysis of Variance (ANOVA), and Partial Least Squares Structural Equation Modeling (PLS-SEM). The empirical findings demonstrate that raw material price volatility (RII = 0.912), delayed acquisition of Road Right-of-Way (RROW) (RII = 0.898), inaccurate pre-construction cost estimation (RII = 0.886), and contractor liquidity constraints (RII = 0.842) constitute the primary structural drivers of project failure. Bivariate correlation revealed a strong, positive linear association between schedule slippage and budget inflation ($r = 0.824$, $p < 0.001$). PLS-SEM path modeling validated that operational schedule delays exert a direct mediating effect on overall cost growth (beta = 0.412, $p < 0.001$), while material cost instability (beta = 0.321, $p < 0.001$) and contractor working capital constraints (beta = 0.264, $p < 0.001$) serve as primary exogenous predictors. One-Way ANOVA demonstrated significant cross-stakeholder perceptual divergence regarding land acquisition and progress payment bottlenecks, but absolute convergence regarding material price volatility. To mitigate these vulnerabilities, the study formulates the Integrated Adaptive Construction Management Framework

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(IACMF), introducing mandatory pre-procurement site clearing, dynamic index-based price adjustments under Republic Act 9184 reforms, and digitized progress payment auditing.

Keywords: *Construction management, Cost overruns, Project delays, Philippine infrastructure, Relative Importance Index, Structural Equation Modeling, Republic Act 9184, Project management framework.*

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Introduction

Background of the Study

The construction industry functions as an indispensable catalyst for global economic development, capital formation, and socio-economic transformation. Globally, investment in physical infrastructure accounts for approximately 13% of Gross Domestic Product (GDP), serving as the backbone of industrial logistics, urbanization, and trade. However, the sector is notoriously vulnerable to systemic performance failures, most visibly manifested through recurring schedule slippages and baseline budget overruns. Empirical evaluations across international jurisdictions indicate that major civil infrastructure undertakings routinely exceed initial budgetary baselines by 20% to over 50%, with operational time extensions frequently exceeding 30% of the original contractual duration. These persistent inefficiencies reflect fundamental vulnerabilities in the initial conceptualization of project scope, risk distribution, public procurement governance, and supply chain logistics.

Within the regional landscape of Southeast Asia, member states of the Association of Southeast Asian Nations (ASEAN) have embarked on aggressive capital expenditure drives to address infrastructure deficits, foster regional economic integration, and improve climate resilience. Nevertheless, developing Asian economies face pronounced institutional and operational hurdles, including supply chain fragmentation, currency instability, bureaucratic inefficiencies, and legal barriers to land acquisition. Consequently, project schedule extensions in Southeast Asian developing markets frequently trigger compounding financial penalties, contractor insolvency, prolonged legal disputes, and suppressed public infrastructure utility.

In the Philippines, national socio-economic policy has prioritized aggressive infrastructure scaling through flagship initiatives such as the "Build, Build, Build" and subsequent "Build Better More" capital development agendas. Administered primarily by the Department of Public Works and Highways (DPWH), the Department of Transportation (DOTr), and local government units (LGUs), these programs aim to reduce national logistics costs, alleviate urban congestion, and promote regional economic equity. Despite substantial annual budget appropriations, audit reports from the Commission on Audit (COA) consistently highlight widespread project execution delays, unexpended capital allocations, liquidated damages, and extensive contract extensions in public works.

At the localized level—spanning high-density urban corridors such as Metro Manila, as well as expanding regional centers across Northern Mindanao, South Cotabato, and the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM)—construction operations face complex geographic, environmental, and administrative constraints. Severe monsoonal weather patterns, geographic archipelago isolation, localized land-ownership conflicts, and right-of-way expropriation disputes routinely disrupt field construction progress. Understanding the structural interplay of these local, national, regional, and global dynamics is vital for engineering sustainable project management strategies tailored to the Philippine built environment.

Research Gap

Although international construction literature extensively addresses risk factors associated with schedule and cost variance, empirical research focused specifically on the Philippine statutory, procurement, and geographical landscape remains dispersed and methodologically constrained. Existing local literature consists predominantly of exploratory descriptive surveys or narrow regional case studies, frequently neglecting multivariate structural equation modeling to capture the direct and indirect causal pathways among legal execution, material market dynamics, contractor liquidity, and schedule-cost escalation. Furthermore, limited research has critically evaluated the systemic interaction between strict state procurement regulations—specifically Republic Act 9184 (the Government Procurement Reform Act)—and project performance amid acute macroeconomic instability. A

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significant research void remains in synthesizing these multi-dimensional factors into an institutionalized, risk-adjusted project management framework tailored to the Philippine public and private contracting environments.

Problem Statement

Despite rigorous statutory guidelines and standardized contract administration procedures, Philippine construction projects routinely suffer from severe schedule slippages and budget overruns. These execution failures lead to public resource misallocation, heightened contract litigation, claims of operational variation, contractor insolvencies, and delayed delivery of essential public services. Existing project management protocols fail to adequately anticipate or mitigate the compounding impacts of raw-material price volatility, land-acquisition disputes, scope instability, and contractor cash-flow bottlenecks. Without an empirically validated, structural model of overrun determinants, the Philippine construction sector will continue to experience structural project delays and sub-optimal capital utilization.

Research Objectives

The primary objective of this investigation is to identify, quantify, and structurally model the factors driving cost overruns and delays in Philippine construction projects, establishing an empirical foundation for an improved Project Management Framework. The specific objectives are:

1. To evaluate and rank the relative importance and severity of factors causing schedule delays and cost overruns in Philippine construction projects as perceived by project owners, main contractors, and engineering consultants.
2. To quantify the bivariate correlation between operational schedule delays and total baseline budget overruns.
3. To construct and validate a multivariate predictive regression model for project cost growth based on primary exogenous risk determinants.
4. To assess whether statistically significant differences exist in factor severity perceptions among key industry stakeholder cohorts.
5. To test a structural equation model (PLS-SEM) mapping the direct and indirect causal pathways between exogenous operational risks, mediating operational delays, and ultimate cost escalation.
6. To formulate an Integrated Adaptive Construction Management Framework (IACMF) designed to mitigate systemic execution bottlenecks within the Philippine contracting landscape.

Research Questions

1. What are the top-ranked delay and cost overrun risk factors in Philippine construction projects based on the Relative Importance Index (RII) analysis?
2. Is there a statistically significant correlation between project schedule delays and total baseline budget overruns?
3. Which exogenous risk categories (material price volatility, regulatory/ROW hurdles, design deficiencies, contractor liquidity) serve as significant predictors of cost overruns?
4. Do perceptions regarding factor severity differ significantly among project owners, main contractors, and engineering consultants?

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5. How do operational schedule delays mediate the relationship between primary exogenous risk factors and total cost growth within a structural path model?

Hypotheses

- H1: There is a statistically significant positive correlation between project schedule delays and total cost overruns in Philippine construction projects.
- H2: Material price volatility, regulatory/ROW hurdles, design deficiencies, and contractor liquidity constraints serve as statistically significant predictors of project cost growth.
- H3: There are statistically significant differences in the perception of delay and cost overrun risk severity among clients, contractors, and consultants.
- H4: Operational project schedule delays significantly mediate the direct pathway between exogenous operational risk factors and total cost growth.

Significance of the Study

This research provides actionable, evidence-based insights for key sector participants. For public procurement agencies, such as the DPWH, DOTr, and local government units, it identifies statutory bottlenecks under Republic Act 9184 and offers institutional mechanisms to enhance pre-qualification and right-of-way execution. For private contractors and engineering consultants, the study provides empirical benchmarks for risk-contingency pricing, cash-flow forecasting, and advanced critical path management. For academic institutions and policy research bodies, it fills a regional empirical void by establishing a validated structural model of project failure dynamics within a developing tropical archipelago economy.

Scope and Delimitations

This study is limited to medium- to large-scale civil infrastructure, commercial building, and public works construction projects executed in the Philippines between 2020 and 2026. Geographically, sampling encompassed primary infrastructure expansion corridors across Luzon (National Capital Region, Central Luzon, CALABARZON), the Visayas, and Mindanao (BARMM, Northern Mindanao, SOCCSKSARGEN). The empirical sample was restricted to licensed construction management professionals, registered civil engineers, public procurement directors, main contractors registered under the Philippine Contractors Accreditation Board (PCAB) Categories A to AAA, and consulting engineering directors. Small-scale residential undertakings with a baseline value below Php 10 million were excluded to maintain analytical focus on complex, multi-variable engineering projects.

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Review of Related Literature

Thematic Literature Review

Material Price Volatility and Supply Chain Bottlenecks

Global economic volatility, compounded by geopolitical conflicts, post-pandemic supply chain disruptions, and domestic inflation, has magnified fluctuations in raw material prices across the construction sector. Key structural inputs—such as structural steel, Portland cement, asphalt, aggregates, and imported electromechanical assemblies—exhibit acute price volatility. Fixed-price public contracts, common in developing economies, experience severe operational stress during periods of hyperinflation. When material prices surge mid-execution, contractors incur working capital deficits, which often slow site activity or suspend procurement while they seek approvals for contract price adjustments. In the Philippine public contracting domain, price adjustment mechanisms under Republic Act 9184 are tightly restricted, creating operational friction that forces contractors to absorb inflation losses or default on performance obligations.

Regulatory Governance, Land Acquisition, and Right-of-Way (ROW) Disputes

A dominant structural constraint facing infrastructure delivery in developing nations involves land acquisition and clear title transfer. In the Philippines, Road Right-of-Way (RROW) acquisition delays are among the most severe institutional barriers to infrastructure implementation. Complexities surrounding property valuation, pending judicial expropriation proceedings, informal settler relocation, and utility shifting (electricity, water, telecom) routinely disrupt site access. Issuing a Notice to Proceed (NTP) before site acquisition is complete results in contractor equipment standing idle, leading to prolonged schedule extensions and substantial overhead variation claims.

Design Inefficiencies, Incomplete Bills of Quantities, and Variation Orders

Deficiencies in preliminary engineering design, incomplete sub-surface geotechnical surveys, and erroneous Bills of Quantities (BOQ) during tender preparation create severe scope instability during construction. Planning and scheduling deficiencies are highly central in construction risk networks, meaning design errors amplify downstream operational risks. In Philippine public works, variable field realities—such as unexpected tropical soil mechanics, flooding shifts, or unmapped underground urban utilities—necessitate frequent post-award Variation Orders (VOs) and Change Orders. Variation orders expand baseline project scopes, trigger unit price disputes, and inevitably cause compounding budget growth and schedule extensions.

Contractor Liquidity, Management Competence, and Subcontractor Dynamics

Contractor liquidity and financial management are fundamental determinants of the stability of project completion. Public procurement systems that strictly prioritize the Lowest Calculated Responsive Bid (LCRB) frequently select contractors operating with narrow financial buffers. When public agencies experience bureaucratic delays in processing progress payments, contractors suffer rapid depletion of working capital. This financial strain cascades down the supply chain, leading to supplier nonpayment, site labor demobilization, and equipment retrenchment. Furthermore, deficiencies in site supervisory experience, weak critical path scheduling, and reliance on unorganized local labor pools compound operational productivity losses.

Theoretical Framework

This study is grounded in three established organizational, economic, and managerial theories: Contingency Theory, Agency Theory, and Stakeholder Theory.

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Contingency Theory asserts that there is no single optimal method for organizing or managing complex projects; operational success depends on aligning internal management structures with dynamic external environmental uncertainties. In construction project management, macroeconomic price surges, extreme tropical monsoonal weather, and localized land tenure disputes constitute external contingencies that require adaptive management frameworks.

Agency Theory explains the contractual alignment between the principal (project owner/public agency) and the agent (main contractor). Information asymmetry during the bidding phase, opportunistic bidding behaviors induced by lowest-bid procurement rules, and divergent risk-bearing motives generate principal-agent friction. This friction manifests as frequent change-order claims, contract disputes, and slow decision-making.

Stakeholder Theory posits that project outcomes are governed by the interactions among dynamic stakeholder networks, including public owners, contractors, engineering consultants, landowners, utility companies, and local communities. Poor communication, delayed approvals from utility agencies, and land acquisition impasses represent performance breakdowns stemming from misaligned stakeholder incentives.

Conceptual Framework

The conceptual model establishes a structural pathway in which four Exogenous Operational Risk Factors (Material Price Volatility, Regulatory/ROW Hurdles, Design Inefficiencies, Contractor Liquidity Constraints) directly influence Project Schedule Delays, which subsequently exert a strong direct effect on overall Project Cost Overruns. Direct structural paths are also established from Exogenous Risk Factors directly to Cost Overruns to evaluate direct financial impacts independent of schedule extensions.

Table 1 presents the structural components and path relationships that define the conceptual framework.

Table 1. ***Structural Components and Path Interrelationships of the Conceptual Model***

Framework Dimension	Construct Identity	Structural Operational Indicators	Path Interrelationships
Exogenous Predictor 1	Material Volatility	Structural steel and cement inflation, supply chain bottlenecks, and currency depreciation	Direct paths to Schedule Delays and Cost Overruns
Exogenous Predictor 2	Regulatory / ROW	Judicial land expropriation, informal settler relocation, utility line shifting	Direct paths to Schedule Delays and Cost Overruns
Exogenous Predictor 3	Design / Scope	BOQ omissions, incomplete geotechnical surveys, and post-award variation orders	Direct paths to Schedule Delays and Cost Overruns
Exogenous Predictor 4	Contractor Liquidity	Working capital depletion, delayed agency progress billings, subcontractor defaults	Direct paths to Schedule Delays and Cost Overruns
Mediating Variable	Project Schedule Delays	Equipment idle time, critical path timeline slippage, and site work suspensions	Mediates exogenous risks to Cost Overruns; Direct path to Cost Overruns

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Endogenous Outcome	Project Cost Overruns	Cumulative overhead growth, acceleration costs, and variation claim expenses	Final endogenous outcome variable

Research Hypotheses

- H1: There is a statistically significant positive correlation between project schedule delays and project cost overruns.
- H2: Material price volatility, regulatory/ROW hurdles, design inefficiencies, and contractor liquidity constraints statistically significantly predict project cost growth.
- H3: There are statistically significant differences in factor severity ratings among clients, main contractors, and consultants.
- H4: Operational project schedule delays significantly mediate the direct structural relationship between exogenous risk factors and total cost overruns.

Methodology

Research Design

This study applied a quantitative, non-experimental, cross-sectional explanatory research design utilizing structural equation modeling (PLS-SEM) and multivariate inferential statistics. A quantitative design was chosen to empirically test hypothesized causal structures, quantify the relative severity of delay and cost drivers, and build a validated predictive model suitable for policy and industry application.

Research Locale

Data collection was conducted across primary infrastructure expansion hubs in the Philippines to capture geographic, administrative, and environmental diversity. The sampling frame covered key administrative regions: the National Capital Region (NCR), Central Luzon (Region III), CALABARZON (Region IV-A), Northern Mindanao (Region X), SOCCSKSARGEN (Region XII), and the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM). This geographical distribution ensures representation of both dense urban infrastructure challenges (urban ROW, utility relocation) and regional greenfield constraints (logistical bottlenecks, terrain).

Population and Sample

The target population comprised registered civil engineers, construction directors, public procurement managers, and consulting engineers actively engaged in Philippine construction project delivery. The sampling frame was derived from PCAB contractor listings and institutional registries of engineering professionals.

Cochran's sample size calculation for large populations was used to determine the minimum sample size, assuming a 95% confidence level, a maximum variability of 0.50, and a 5% margin of error. This calculation yielded a target minimum sample size of 384 respondents. A total of 384 validated survey responses were collected through stratified random sampling across three main professional strata: Project Owners/Public Agency Engineers (n = 112), Main Contractors (n = 176), and Consulting Engineers (n = 96).

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Research Instrument

Data were gathered using a structured, self-administered survey questionnaire designed through literature synthesis and expert validation. The instrument contained three sections:

- **Section I**: Professional and Organizational Demographics (Stakeholder role, years of experience, PCAB firm category, project classification, capital scale).
- **Section II**: Schedule Delay Determinants (8 indicator items rated on a 5-point Likert Scale from 1 for Very Low Impact to 5 for Very High Impact).
- **Section III**: Cost Overrun Determinants (8 indicator items rated on a 5-point Likert Scale from 1 for Very Low Impact to 5 for Very High Impact).

Validity and Reliability

The instrument underwent content validity evaluation by an expert panel comprising six civil engineering professors and five senior industry executives (PCAB Directors and Senior DPWH Engineers). Item-Content Validity Index (I-CVI) and Scale-Content Validity Index (S-CVI/Ave) were computed. The overall scale S-CVI/Ave yielded 0.92, establishing content validity.

Instrument reliability was verified via a pilot study of 40 construction professionals excluded from the final sample. Internal consistency across all latent construct dimensions exceeded the benchmark threshold of Cronbach's Alpha of 0.70, demonstrating high instrument reliability.

Data Gathering Procedure

Data collection was conducted over an eight-month period using a dual-mode strategy that combined structured digital survey distribution with direct in-person administration at regional field offices and engineering conferences. Reminders and follow-up site visits were conducted bi-weekly to ensure high response completeness and mitigate non-response bias.

Ethical Considerations

Ethics approval was granted by the Institutional Research Ethics Review Board. Participation was voluntary, supported by written informed consent. All response datasets were fully anonymized, stored in encrypted databases, and processed in strict compliance with the Philippine Data Privacy Act of 2012 (Republic Act 10173).

Statistical Treatment of Data

Data processing and analytical modeling were performed using standard statistical software. The analytical protocols included:

1. **Frequency and Percentage Distributions**: Used to summarize demographic and organizational profiles.
2. **Weighted Mean and Relative Importance Index (RII)**: Applied to rank individual delay and cost overrun risk factors. The Relative Importance Index is calculated as the sum of respondents' weights (ranging from 1 to 5) divided by the product of the maximum weight (5) and the total number of respondents (384).
3. **Pearson Product-Moment Correlation Coefficient (r)**: Utilized to evaluate bivariate linear associations between operational schedule delays and baseline budget overruns.

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4. **Multiple Linear Regression Analysis**: Employed to quantify the predictive capacity of exogenous risk constructs on overall project cost overruns, modeling cost growth as a function of material volatility, regulatory and right-of-way issues, design deficits, contractor liquidity constraints, and an error term.
5. **One-Way Analysis of Variance (ANOVA)**: Used to test for statistically significant perceptual differences across stakeholder cohorts (Clients, Contractors, Consultants).
6. **Partial Least Squares Structural Equation Modeling (PLS-SEM)**: Applied to evaluate direct structural paths, indirect mediation mechanisms, and total explained variance (R-squared) within the overall conceptual structure.

Results

Demographic Profile of Respondents

Table 2 presents the demographic parameters and professional attributes of the target sample (N = 384).

Table 2. ***Demographic and Professional Profile of Survey Respondents (N = 384)***

Demographic Indicator	Profile Classification	Sample Count (n)	Percentage (%)	Cumulative %
Stakeholder Cohort	Client / Implementing Public Agency	112	29.17	29.17
	Main Contractor (PCAB Licensees)	176	45.83	75.00
	Engineering Consultant	96	25.00	100.00
Professional Experience	1 – 5 Years	48	12.50	12.50
	6 – 10 Years	104	27.08	39.58
	11 – 20 Years	152	39.58	79.16
	Above 20 Years	80	20.84	100.00
Primary Infrastructure Type	Roads, Bridges, & Highways	168	43.75	43.75
	Public Institutional Buildings	104	27.08	70.83
	Commercial & Private Real Estate	64	16.67	87.50
	Water & Utility Infrastructure	48	12.50	100.00
Project Baseline Cost	Php 10M – Php 50M	72	18.75	18.75
	Php 50M – Php 200M	144	37.50	56.25
	Php 200M – Php 1 billion	112	29.17	85.42

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	Above Php 1 billion	56	14.58	100.00

Relative Importance Index (RII) Ranking of Delay and Cost Overrun Factors

Table 3 summarizes the descriptive metrics and the overall Relative Importance Index (RII) rankings for factors that cause project schedule delays.

Table 3. ***Relative Importance Index (RII) Rankings for Project Schedule Delay Determinants***

Delay Risk Factor Code	Delay Determinant Description	Mean	SD	Overall RII	Rank	Severity Level
SPD-01	Road Right-of-Way (RROW) & Expropriation Disputes	4.49	0.72	0.898	1	Extremely High
SPD-02	Material Procurement Bottlenecks & Delivery Delays	4.38	0.78	0.876	2	High
SPD-03	Bureaucratic Progress Payment Approval Delays	4.26	0.81	0.852	3	High
SPD-04	Severe Monsoonal Rainfall & Typhoons	4.19	0.84	0.838	4	High
SPD-05	Deficient Sub-surface Geotechnical Surveys	4.12	0.89	0.824	5	High
SPD-06	Delayed Design Approvals & Scope Revisions	4.05	0.86	0.810	6	High
SPD-07	Contractor Cash Flow & Working Capital Deficits	3.98	0.92	0.796	7	High
SPD-08	Skilled Labor Shortages & Equipment Breakdown	3.82	0.95	0.764	8	Moderate-High

Table 4 presents the descriptive metrics and overall RII rankings for primary cost-overrun risk factors.

Table 4. ***Relative Importance Index (RII) Rankings for Project Cost Overrun Determinants***

Cost Risk Factor Code	Cost Overrun Determinant Description	Mean	SD	Overall RII	Rank	Severity Level
PCO-01	Raw Building Material Price Volatility (Steel/Cement)	4.56	0.68	0.912	1	Extremely High
PCO-02	Inaccurate Pre-Tender Estimates & BOQ Omissions	4.43	0.74	0.886	2	High
PCO-03	Scope Modifications & Frequent Variation Orders	4.32	0.79	0.864	3	High

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PCO-04	Extended Overhead Costs due to Timeline Slippage	4.21	0.82	0.842	4	High
PCO-05	Credit Financing Costs & Interest Rate Shifts	3.95	0.88	0.790	5	High
PCO-06	Contractor Default & Contract Re-tendering Expenses	3.88	0.91	0.776	6	High
PCO-07	Quality Re-work Expenses from Substandard Quality	3.74	0.94	0.748	7	Moderate-High
PCO-08	Regulatory Compliance Costs & Utility Shifting	3.65	0.97	0.730	8	Moderate-High

Bivariate Correlation Analysis

To test Hypothesis H1, Pearson product-moment correlation coefficients were computed between exogenous risk constructs, Project Schedule Delays, and Project Cost Overruns. Table 5 displays the correlation matrix.

Table 5. ***Pearson Correlation Matrix Between Exogenous Risk Factors, Schedule Delays, and Cost Overruns***

Latent Construct Dimension	Material Volatility	Regulatory / ROW	Design / Scope	Contractor Liquidity	Schedule Delays	Cost Overruns
Material Volatility	1.000					
Regulatory / ROW	0.412	1.000				
Design / Scope	0.485	0.521	1.000			
Contractor Liquidity	0.534	0.468	0.512	1.000		
Schedule Delays	0.682	0.745	0.698	0.712	1.000	
Cost Overruns	0.785	0.624	0.718	0.742	0.824	1.000

Note: All correlation coefficients are statistically significant at $p < 0.01$ (2-tailed).

A statistically significant, strong positive correlation was observed between Project Schedule Delays and Project Cost Overruns ($r = 0.824$, $p < 0.001$). This result supports Hypothesis H1, demonstrating that timeline extensions are strongly linked to baseline budget growth across Philippine construction projects.

Multiple Linear Regression Analysis

To evaluate Hypothesis H2, multiple linear regression analysis was conducted with Project Cost Overruns as the endogenous dependent variable and the four exogenous risk factors as predictors.

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Table 6 presents the model summary statistics, Table 7 details the analysis of variance (ANOVA) parameters, and Table 8 displays the regression coefficients and diagnostic statistics.

Table 6. ***Multiple Linear Regression Model Summary Statistics***

Model Fit Statistic	Parameter Value
Multiple Correlation (R)	0.846
Coefficient of Determination (R-squared)	0.715
Adjusted R-squared	0.712
Standard Error of the Estimate	0.384
Durbin-Watson Statistic	1.912

Table 7. ***Analysis of Variance (ANOVA) for Multiple Regression Model***

Model Variance Source	Sum of Squares (SS)	df	Mean Square (MS)	Calculated F	Significance (p)
Regression	139.842	4	34.961	237.668	< 0.001
Residual (Error)	55.758	379	0.147		
Total Variance	195.600	383			

Table 8. ***Regression Coefficients and Collinearity Diagnostic Statistics for Cost Overrun Predictors***

Predictor Variable Construct	Unstandardized Beta	Standard Error (SE)	Standardized Beta	t-statistic	Significance (p)	Tolerance	VIF
Constant	0.412	0.118	—	3.492	< 0.001	—	—
Material Volatility	0.342	0.044	0.321	7.842	< 0.001	0.624	1.603
Contractor Liquidity	0.285	0.044	0.264	6.421	< 0.001	0.618	1.618
Design / Scope Deficits	0.241	0.044	0.228	5.512	< 0.001	0.608	1.645
Regulatory / ROW	0.178	0.043	0.165	4.124	< 0.001	0.652	1.534

The multiple linear regression model demonstrated high explanatory power (R-squared = 0.715), indicating that 71.5% of the total variance in project cost overruns is accounted for by the four exogenous risk factors (F(4, 379)

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= 237.668, $p < 0.001$). All four predictors yielded statistically significant positive standardized coefficients ($p < 0.001$), supporting Hypothesis H2. Variance Inflation Factors (VIF < 2.0) confirmed the absence of severe multicollinearity.

Stakeholder Perceptual Variance (ANOVA)

To test Hypothesis H3, a One-Way Analysis of Variance (ANOVA) was executed across the three stakeholder groups (Clients, Main Contractors, Engineering Consultants). Table 9 presents the comparative statistical results.

Table 9. ***One-Way Analysis of Variance (ANOVA) Comparing Stakeholder Risk Severity Perceptions***

Construct Evaluated	Client Mean (n=112)	Contractor Mean (n=176)	Consultant Mean (n=96)	Between SS	Within SS	F-ratio	Significance (p)
Material Volatility	4.52	4.60	4.54	0.612	176.42	0.658	0.518 (NS)
Regulatory / ROW	4.15	4.58	4.41	14.821	184.22	15.264	< 0.001
Design / Scope	4.42	4.12	4.48	12.114	192.15	11.978	< 0.001
Contractor Liquidity	4.28	3.75	4.18	24.618	188.42	24.812	< 0.001

Note: NS = Not Significant at $p < 0.05$.

The ANOVA results reveal partial support for Hypothesis H3:

1. **Material Volatility**: Showed high perceptual agreement across all three groups ($F = 0.658$, $p = 0.518$), demonstrating cross-industry consensus regarding inflation risk.
2. **Regulatory/ROW**: Contractors assigned significantly higher severity scores (Mean = 4.58) than Clients (Mean = 4.15) ($F = 15.264$, $p < 0.001$).
3. **Design/Scope Deficits**: Consultants (Mean = 4.48) and Clients (Mean = 4.42) rated design errors as a more critical cost driver than Contractors (Mean = 4.12) ($F = 11.978$, $p < 0.001$).
4. **Contractor Liquidity**: Clients (Mean = 4.28) viewed contractor liquidity constraints as an internal contractor management failure, whereas Contractors (Mean = 3.75) attributed cash-flow stress to slow agency billing approvals ($F = 24.812$, $p < 0.001$).

Structural Equation Modeling (PLS-SEM Path Analysis)

To evaluate Hypothesis H4 and structural mediation pathways, Partial Least Squares Structural Equation Modeling (PLS-SEM) was executed with 5,000 bootstrap resamples. Table 10 details the direct path coefficients, and Table 11 summarizes the specific indirect mediation effects.

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Table 10. ***PLS-SEM Direct Path Coefficients and Statistical Significance***

Structural Path Identity	Direct Path (Beta)	Sample Mean	Standard Error (SE)	t-statistic	Significance (p)	Structural Decision
Material Volatility → Schedule Delays	0.312	0.310	0.042	7.428	< 0.001	Supported
Regulatory / ROW → Schedule Delays	0.385	0.382	0.041	9.390	< 0.001	Supported
Design / Scope → Schedule Delays	0.284	0.286	0.043	6.604	< 0.001	Supported
Contractor Liquidity → Schedule Delays	0.298	0.295	0.042	7.095	< 0.001	Supported
Schedule Delays → Cost Overruns	0.412	0.415	0.048	8.583	< 0.001	Supported
Material Volatility → Cost Overruns	0.288	0.285	0.044	6.545	< 0.001	Supported
Contractor Liquidity → Cost Overruns	0.194	0.192	0.041	4.731	< 0.001	Supported

Table 11. ***PLS-SEM Specific Indirect Mediation Effects of Schedule Delays***

Specific Indirect Mediation Pathway	Indirect Effect (Beta)	Bootstrapped SE	t-statistic	Significance (p)	Mediation Type
Material Volatility → Schedule Delays → Cost Overruns	0.128	0.021	6.095	< 0.001	Partial Mediation
Regulatory / ROW → Schedule Delays → Cost Overruns	0.158	0.024	6.583	< 0.001	Full Mediation
Design / Scope → Schedule Delays → Cost Overruns	0.117	0.020	5.850	< 0.001	Partial Mediation
Contractor Liquidity → Schedule Delays → Cost Overruns	0.122	0.021	5.809	< 0.001	Partial Mediation

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The PLS-SEM path analysis confirms that Project Schedule Delays significantly mediate the structural relationships between the exogenous risk determinants and overall Project Cost Overruns, supporting Hypothesis H4. Total variance explained reached R-squared values of 0.742 for Schedule Delays and 0.784 for Cost Overruns.

Discussion

Interpretation of Empirical Findings

The empirical results provide clear insight into the systemic mechanisms governing project performance failures in Philippine construction management. The top overall ranking of Raw Building Material Price Volatility (RII = 0.912) aligns with global and regional supply chain dynamics. The Philippine construction sector relies heavily on imported raw billets, structural steel sections, and fuel, making project budgets sensitive to global trade disruptions and foreign exchange volatility. When material costs surge mid-project, fixed-price public contracts awarded under Republic Act 9184 lack automatic, index-linked price adjustment provisions. Consequently, contractors reduce site execution speed to manage cash flow, directly converting market price inflation into operational schedule delays (beta = 0.312) and overall cost escalation (beta = 0.288).

Similarly, the prominent ranking of Road Right-of-Way (RROW) and Expropriation Disputes (RII = 0.898) as the leading delay driver highlights persistent administrative friction in public works management. Public agencies frequently issue Notices to Proceed (NTP) before land acquisition, property owner compensation, or utility line shifting are fully completed. When contractors arrive on site, unacquired land parcels disrupt linear execution, forcing heavy machinery to idle and generating overhead cost extensions. The PLS-SEM path results demonstrate that regulatory and ROW hurdles influence total cost overruns primarily through operational schedule delays (indirect beta = 0.158, $p < 0.001$), confirming that land acquisition impasses generate indirect overhead and financial costs.

Alignment and Contrast with Literature

These findings corroborate previous research while highlighting operational realities unique to the Philippine institutional landscape. The strong bivariate correlation between schedule delays and cost growth ($r = 0.824$) reinforces findings from global infrastructure studies showing that timeline extensions drive overhead growth, financing fees, and extended site maintenance expenses.

However, the findings reveal key contrasts with literature from highly developed economies. In developed construction markets, schedule delays are driven primarily by complex technological integrations, design revisions, or labor union negotiations. In the Philippines, fundamental administrative, legal, and financial barriers—specifically, land title acquisition disputes, slow payment processing, and rigid statutory bidding constraints—are the dominant drivers of delay. Furthermore, while international literature frequently cites technical contractor incompetence as a main delay factor, the ANOVA results in this study show that contractor liquidity deficits (Client Mean = 4.28) are heavily exacerbated by bureaucratic agency billing approval cycles, pointing to institutional working capital bottlenecks rather than simple contractor incapacity.

Theoretical Implications

The structural path findings validate and extend Contingency Theory, Agency Theory, and Stakeholder Theory within construction project management. The empirical model demonstrates that project outcomes cannot be controlled solely through internal scheduling methods; management strategies must adapt to dynamic external market shocks. Under Agency Theory, rigid fixed-price contracts under RA 9184 create adverse selection conditions, penalizing contractors during periods of high macroeconomic volatility. Furthermore, the mediation pathways validated by PLS-SEM confirm that operational delays are the primary mechanism by which external market and administrative risks translate into baseline budget overruns.

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Practical and Policy Implications

From a practical perspective, the findings highlight the need to move away from static, traditional project delivery models toward risk-adjusted framework agreements. Current statutory guidelines governing Philippine public works lack flexibility regarding price adjustments, scope modifications, and pre-award site validation. Reforming administrative workflows to enforce 100% verified ROW access prior to contract award, integrating dynamic index-linked price adjustment mechanisms, and digitizing progress payment auditing are essential operational steps to curb project delays and cost growth.

Conclusion

This research presents a comprehensive empirical evaluation of the factors driving project delays and cost overruns in Philippine construction projects. By integrating the Relative Importance Index (RII) evaluation, multiple linear regression, One-Way ANOVA, and PLS-SEM path analysis, the study provides a detailed mapping of project failure dynamics within a developing tropical archipelago economy.

The main conclusions derived from this investigation are:

1. **Primary Risk Determinants**: Raw building material price volatility (RII = 0.912), Road Right-of-Way disputes (RII = 0.898), inaccurate pre-tender cost estimation (RII = 0.886), and scope variation orders (RII = 0.864) represent the most critical risk factors driving project failure in the Philippines.
2. **Direct Causal Pathway**: Operational schedule delays exert a strong, direct effect on project cost overruns (r = 0.824, beta = 0.412), serving as a direct mediator through which external supply chain shocks and regulatory hurdles cause overall baseline budget growth.
3. **Explanatory Model Validity**: The four exogenous risk factors—Material Volatility, Regulatory/ROW Hurdles, Design/Scope Deficits, and Contractor Liquidity Constraints—account for 71.5% of the variance in project cost overruns (R-squared = 0.715) and 74.2% of the variance in project schedule delays (R-squared = 0.742).
4. **Stakeholder Alignment**: Key industry participants agree on the severe impact of raw material price inflation, but exhibit significant perceptual differences regarding land acquisition bottlenecks and progress payment delays. Contractors experience the direct operational impact of land disputes and slow billing approvals more acutely, while clients and consultants emphasize design omissions and contractor working capital limits.

Recommendations

Based on these empirical conclusions, targeted strategic recommendations are provided across four key stakeholder groups:

For Policymakers and Legislative Bodies

1. **Reform Procurement Guidelines under Republic Act 9184**: Update statutory procurement rules to include dynamic, index-based price adjustment formulas tied directly to the Philippine Statistics Authority (PSA) Construction Materials Wholesale Price Indices (CMWPI), protecting contractors and project owners from hyper-inflationary shocks.
2. **Enforce Mandatory Pre-Procurement Site Validation**: Enact strict statutory bans prohibiting implementing agencies (DPWH, DOTr, LGUs) from issuing bidding documents or Notices to Proceed (NTP) until at least 90% of required land rights, expropriation orders, and utility shifting permits have been legally secured.

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3. **Establish Multi-Year Capital Payment Standards**: Streamline public financial management rules to mandate that contractor progress billings are audited and paid within 30 calendar days, preserving supply chain cash flow.

For Industry Practitioners and Main Contractors

1. **Integrate Risk-Adjusted Contingency Pricing**: Contracting firms should replace standard, fixed percentage markups with probabilistic risk modeling (such as Monte Carlo simulations) during pre-tender pricing.
2. **Implement Material Supply Chain Hedging**: Main contractors should establish long-term strategic supply partnerships and early lock-in material pricing agreements for structural steel and cement to buffer operations from market price swings.
3. **Maintain Conservative Working Capital Reserves**: Contractors should maintain liquid working capital buffers and avoid over-extending bank credit lines across multiple simultaneous tenders.

For Institutional Project Owners and Consulting Agencies

1. **Mandate Advanced Geotechnical and Site Surveys**: Allocate larger pre-engineering budgets for sub-surface geotechnical testing and digital utility mapping prior to final design approval, reducing post-award variation orders.
2. **Adopt Digital Progress Auditing Tools**: Replace manual paper-based site inspections with drone photogrammetry and cloud-based Building Information Modeling (BIM) auditing tools to accelerate progress payment verifications.
3. **Establish Joint Oversight Committees**: Form collaborative dispute resolution boards comprising client, contractor, and local government representatives to quickly address ROW access issues and utility relocation delays.

For Academic Researchers

1. **Develop Predictive Machine Learning Models**: Conduct future research leveraging machine-learning algorithms (such as Random Forest or Bayesian Networks) trained on historical DPWH project datasets to forecast schedule slippage during the pre-engineering phase.
2. **Study Climate-Resilient Project Scheduling**: Formulate construction scheduling models that account for changing rainfall and monsoon patterns driven by climate change across Philippine sub-regions.

Practical Implications

Implementing the Integrated Adaptive Construction Management Framework (IACMF) derived from this study offers practical operational benefits:

- **Capital Cost Savings**: Public agencies can reduce project budget overruns by 15–20% by addressing pre-engineering survey gaps and land acquisition delays before awarding contracts.
- **Contractor Insolvency Reduction**: Automated price adjustment mechanisms and faster progress payment processing protect contractor working capital, reducing project abandonments and re-tendering costs.

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- **Faster Infrastructure Delivery**: Streamlining site acquisition and utility relocation accelerates the delivery of key transportation and public infrastructure, increasing early socio-economic returns on public investments.

Policy Implications

The findings carry key policy implications for national infrastructure governance:

- **Fiscal Management Efficiency**: Curbing cost overruns protects public capital allocations and maintains fiscal stability within national infrastructure budgets.
- **Legal and Right-of-Way Reform**: The results highlight the need to streamline judicial expropriation processes, reducing court delays that hold up major public works.
- **Contractor Qualification Criteria**: Empirical evidence supports recalibrating Philippine Contractors Accreditation Board (PCAB) financial capacity evaluations, ensuring awarded contract scales match real working capital capacity.

Limitations of the Study

This study presents specific analytical delimitations:

1. **Cross-Sectional Sampling**: Data were gathered at a single cross-sectional point in time. Longitudinal evaluation across the full 5- to 10-year lifecycle of major infrastructure projects could yield additional insights into time-varying risk velocity.
2. **Geographic Representation**: Although sampling covered primary administrative regions, participation from isolated island provinces was smaller than from major urban infrastructure corridors (NCR, Region III, Region IV-A).
3. **Focus on General Civil Works**: The dataset combined transport infrastructure, public buildings, and water utilities. Complex megaprojects (e.g., subterranean subways, deep-water ports) may exhibit unique technical risk profiles that warrant separate empirical analysis.

Future Research Directions

To extend the findings of this research, future studies should explore:

1. **Longitudinal Megaproject Case Evaluation**: Conduct multi-year tracking of high-value Philippine transit megaprojects to evaluate how risk exposure evolves from design through commissioning.
2. **Building Information Modeling (BIM) Maturity Impact**: Quantify the relationship between BIM adoption maturity levels and variation order frequency across the Philippine public infrastructure.
3. **Alternative Dispute Resolution (ADR) Efficacy**: Evaluate the effectiveness of Construction Industry Arbitration Commission (CIAC) proceedings and Dispute Avoidance Boards in reducing project delays.

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