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Schedule Overruns in Vertical Construction Projects: A Review of Delay Factors and Mitigation Strategies

Jandreive Edward P. Mendoza[1], Ebrahim A. Omar[1], Beyonce E. Abellanosa[1], Danielle Lorainne B. Dabbay[1], Cris Adrian Abisha R. Catalan[1], Reuel E. Magsico[1], Aaron John G. Eucogcan[1], Klarrence Jay L. Torilla[1], Reynand Joe P. Pascual[1], Rianne Jade T. Raquel[1]

[1]*Department of Civil Engineering, University of Southern Mindanao, Kabacan, Cotabato, Philippines, 9407*
Corresponding Author Email: eaomar@usm.edu.ph

Abstract- Schedule overruns remain a persistent challenge in vertical construction, driving up costs and delaying operational delivery across diverse project contexts. Hence, this review synthesizes literature on schedule overruns in vertical construction, examining reported delay factors, project consequences, and mitigation approaches, with particular attention to Philippine evidence. A thematic narrative synthesis organizes the cited studies by project and regional context rather than pooling unlike rankings or percentages. Philippine evidence includes a vertical-construction study in Pampanga that reports the relevance of material and labor price changes and tax and exchange-rate fluctuations; studies in Cebu and Mati describe management, workforce, change-order, and financial issues in their respective project settings. Across the wider literature, recurring concerns include contractor cash flow, site coordination, design and approval processes, and material availability. Reported effects include extended project costs and operational disruption, although these outcomes vary by project type and study method. The evidence supports context-specific responses, including realistic procurement and cash-flow planning, coordinated scheduling, and constraint-focused production planning. Digital tools such as 4D building information modeling and lean methods may support these responses, but their effectiveness should be assessed against project-specific data. The reviewed studies do not justify a universal ranking of causes across countries or sectors.

***Keywords*—Delay Factors, Lean Construction, Philippine Construction Industry, Project Management, Schedule Overruns, Vertical Construction, 4D BIM**

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I. INTRODUCTION

Construction is an important contributor to economic activity and infrastructure development. Vertical projects, including residential and commercial buildings, require coordination among design disciplines, contractors, suppliers, and specialist trades. A schedule overrun occurs when actual completion extends beyond the planned or contractual completion date. For building owners and project teams, delays can defer occupancy and revenue, extend site overheads, disrupt trade sequencing, and increase exposure to claims and rework. However, delay rates and cost effects reported in the literature vary with project type, location, study period, and measurement method; broad global percentages should therefore not be treated as universal estimates.

Individual studies illustrate this variation. Research in Gauteng, South Africa, and in Nigeria reports schedule and cost consequences in specific project samples [1], [2]. A study of projects promoted by rural municipalities in Nepal also documents substantial time overruns in its local setting [3]. Other analyses examine cost and schedule overrun in construction projects and delay factors in Hargeisa [4], [5]. These findings establish that delay consequences can be material, but they are not directly comparable because the studies concern different project populations and use different measures. The present review therefore emphasizes studies addressing construction delays, project scheduling, digital construction tools, or lean construction.

Previous studies have examined construction-delay causes, local project settings, and individual mitigation

approaches. Broader reviews of project life cycles and building life-cycle assessment provide context for planning and project evaluation, though they do not estimate delay prevalence [6], [7]. The manuscript's specific contribution is to organize delay evidence around vertical construction while separating direct building evidence from findings drawn from roads, utilities, and other project types, and to highlight the Philippine evidence within that synthesis. The review addresses three questions: (1) What delay factors are reported in vertical and related building projects? (2) What schedule, cost, and operational consequences are described? and (3) What mitigation approaches are reported or proposed, particularly in the Philippine context?

METHODS

A. Review Design and Scope

This article uses a structured narrative review to synthesize literature on schedule overruns in vertical construction, their reported causes and consequences, and approaches to mitigation, with particular attention to Philippine evidence. The review corpus is the 50 sources listed in the submitted manuscript. The dated references span 2000–2025, and the list also contains undated material. The corpus includes empirical studies, reviews, technical papers, and selected reports addressing construction delays, project scheduling, digital construction tools, or lean construction.

Figure 1 documents the review process, from defining the review scope and classifying the evidence to extracting to study information, grouping findings thematically, and synthesizing them within context. Sources were organized according to their relevance to delay factors, schedule or cost consequences, and mitigation approaches. Evidence from vertical and other building projects is treated as direct building evidence; studies of roads, utilities, and other public infrastructure are retained only for contextual comparison and are identified by sector in the synthesis. The supplied manuscript and review materials do not preserve database or repository search records, search dates or terms, eligibility and screening logs, or record counts. These details cannot be reconstructed from the reference list. Accordingly, this article is presented as a narrative review of the cited corpus, not as a systematic or comprehensive database review, and no PRISMA flow counts are claimed.

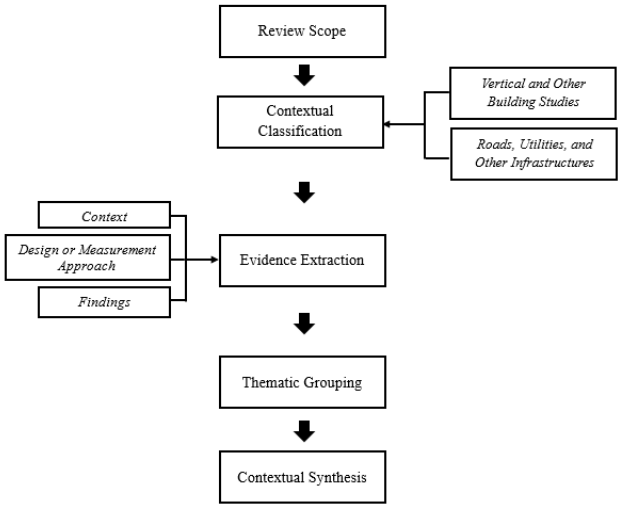


Figure 1. Documented Process of Structured Narrative Review

B. Evidence Extraction and Synthesis

For each cited source, the synthesis records the reported project and geographic context and, where available, the study design or measurement approach, delay factors, consequences, and mitigation measures. Findings are grouped into (a) project finance, procurement, and resources; (b) management, workforce, and coordination; (c) design, approval, and external conditions; (d) schedule, cost, and operational impacts; and (e) mitigation approaches. These five categories are summarized in Figure 2. Each finding is interpreted within its project setting and study context. Percentages, relative-importance indices, and rankings are not pooled because the sources use different samples, sectors, and measurement approaches. Evidence from roads, power, and other infrastructures is identified as adjacent evidence and is not treated as a direct estimate for vertical construction.

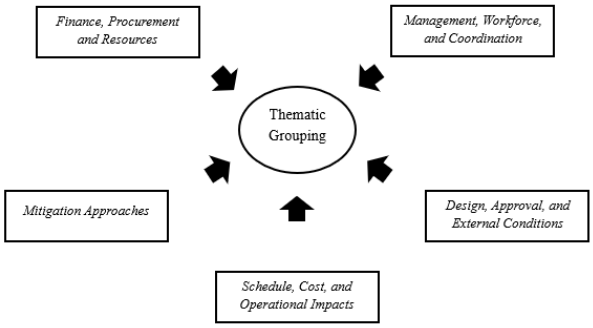


Figure 2. Thematic Categories Used in Evidence Synthesis

C. Bibliometric Analysis

No formal critical-appraisal instrument, meta-analysis, or bibliometric software analysis was applied for this narrative synthesis. The supplied materials contain a formatted reference list but no bibliographic export with abstracts, author keywords, affiliations, citation counts, or cited-reference records. Biblioshiny or VOSviewer mapping is therefore not reported. The absence of documented search and appraisal procedures limits reproducibility, and the findings should be interpreted as a contextual synthesis of the

reported patterns and contexts rather than as a basis for combining percentages from dissimilar samples.

II. RESULTS AND DISCUSSION

A. Global Perspectives and Macroeconomic Influences

The reviewed studies report recurring delay factors across project finance, contractor and subcontractor performance, planning, design, labor, procurement, and external conditions. Their relative importance varies across the study settings; the sources in this review do not establish a universal ranking or a consistent division between developing and developed countries. Studies focused on sustainability and on Algerian projects further illustrate the range of questions and contexts represented in the literature [10], [27]. A cross-regional analysis identifies several broad categories, including management and coordination, design, market and estimation, financial capacity, government processes, and workforce conditions [9]. Earlier syntheses also classify delay causes across heterogeneous construction settings [21], [50].

Country-level findings should be read within their study boundaries. For example, one study of Afghanistan reports governance and security-related conditions, while an Ethiopian study identifies corruption and utility availability among the issues examined [17], [19]. A meta-analysis and a separate review of causes and mitigation measures likewise synthesize evidence drawn from differing study contexts [21], [22]. These cases illustrate context-specific constraints; they do not support general conclusions about entire national or economic groups. The same caution applies when comparing contractor, consultant, owner, and workforce factors across studies.

B. Stakeholder Roles, Procurement, and Finance

A review of Kuwaiti construction-delay studies discusses internal project factors, including contractor site management, subcontractor performance, and design quality [18]. Other studies identify stakeholder-specific issues: consultant delays in evaluating scope changes and design errors in Uganda [16], and planning and coordination concerns in Pakistan [11]. A study of underlying causes and mitigation measures also emphasizes the interaction among project conditions [22]. These findings point to the importance of project governance and role coordination, but differences in study design mean that their reported rankings should not be treated as directly comparable.

Procurement arrangements and payment timing are also discussed in studies from Egypt and Tanzania [25], [26]. These studies describe how low bids, delayed payments, and unrealistic work programs can create financial and scheduling risks. They support careful contractor qualification, payment planning, and realistic baseline schedules; they do not establish that a single procurement model is uniformly responsible for delays across all settings.

C. Vertical-Construction Project Factors

Vertical construction has substantial financing and coordination demands. A high-rise study using AHP and VIKOR identified contractor financial issues and delayed owner resource issuance among its prominent delay risks [23]. Other cited work discusses supply-chain instability, material shortages, and late mechanical equipment delivery [20], [24]. These are reported risks rather than universal causes; their importance will depend on project procurement strategy, location, and construction sequence.

D. Construction Delays in the Philippine Context

Philippine findings vary by location and project type. A study of vertical construction in Pampanga reports the relevance of material and labor price changes and fluctuations in taxes and exchange rates [12]. Qualitative research in Cebu City identifies management, leadership, and workforce concerns in its project sample [15]. The Apayao State College study concerns public-sector projects in a geographically isolated setting and reports weather and material-delivery challenges [8]; it should not be generalized to high-rise buildings. A study in Mati reports differences between public and private project groups, including change orders and workforce characteristics in public projects and management and economic or political conditions in private projects [14]. These studies provide local evidence, but they represent distinct project samples rather than a single Philippine-wide ranking.

Table I. Thematic synthesis of selected evidence and context-specific implications.

Evidence Context and Sources	Reported Pattern and Implication
Philippine vertical construction [12]	Pampanga study reports material and labor price changes and tax and exchange-rate fluctuations. Monitor market exposure and test schedule/cost assumptions against project conditions.
Philippine building/commercial studies [14], [15]	Mati and Cebu findings include management, workforce, change-order, and financial/economic conditions. Interpret each result within its project group and location.
Philippine public projects, adjacent context [8], [13], [39]	Apayao and Philippine road-construction evidence concern public infrastructure settings. Weather, access, material delivery, and BIM scheduling are relevant risks but are not direct high-rise estimates.
High-rise and international construction [18], [20], [23], [24]	Reported concerns include contractor finance, owner resource issuance, site coordination, material supply, and equipment delivery. Prioritize controls according to project-specific risk assessment.

Digital and lean mitigation [35]–[45]	Scheduling, BIM, case-based methods, and lean production offer planning or coordination tools. One cited BIM application concerns road scheduling [39]. The sources vary in sector and evidence strength; avoid claiming universal effectiveness.

III. IMPACT ASSESSMENT

The reported consequences include schedule extension, increased project costs, additional overheads, disruption to subsequent activities, and potential claims or rework. The magnitude of these effects differs across project type, location, and method of measurement; infrastructure figures should not be presented as vertical-building estimates.

A. Schedule Variance and Time Overruns

Earned Value Management (EVM) can be used to track schedule and cost performance against a project baseline [28]. Schedule variance is calculated as SV = EV − PV, where EV is earned value, and PV is planned value; a negative SV indicates that less work value has been earned than planned. The schedule performance index is SPI = EV/PV; an SPI below 1.0 indicates schedule performance below the baseline. These measures describe performance against a plan and do not, by themselves, identify the cause of delay.

B. Financial Consequences and Cost Escalation

Schedule extensions can increase labor, equipment, supervision, financing, and site-overhead costs. The cited estimates for road delays [31] and power infrastructure [28] arise from different sectors and should not be generalized to vertical construction. For building projects, cost effects should be reported using project-specific data and a stated baseline, price period, and method.

C. Forensic Delay Analysis and Responsibility Allocation

When delays occur, responsibility and entitlement depend on the contract terms, events, notice requirements, and applicable law. Construction-delay literature commonly distinguishes excusable and compensable delays, excusable but non-compensable delays, and non-excusable delays [29]. These categories provide a framework for analysis; actual allocation requires project records and contract-specific review.

D. Operational Disruption and Quality Degradation

Attempts to recover lost time through excessive work concurrency may create trade congestion, fatigue, coordination problems, and rework risks [28]. The cited sources support treating these as potential operational consequences, rather than assuming that every delay leads to lower quality or a fixed rework cost.

IV. MITIGATION AND MANAGEMENT STRATEGIES

Mitigation should be matched to the delay mechanisms identified during planning and project execution. The reviewed sources discuss conventional scheduling, risk and resource controls, digital coordination tools, and lean production methods. Their applicability depends on project scale, data quality, procurement arrangements, and the capacity of the project team.

A. Traditional Scheduling and Resource Optimization

The Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) are established approaches for planning activity sequences and schedule uncertainty [32], [33]. CPM is commonly applied when activity durations are treated as deterministic; PERT represents uncertain durations through estimates. Schedule logic and float can help teams identify activities that may affect completion and evaluate resource adjustments. These methods require current, credible activity data and regular updates.

B. Limitations and Adaptations in the Philippine Context

In settings exposed to weather, supply-chain disruption, or approval uncertainty, a baseline CPM or PERT schedule should be supported by risk allowances, contingency planning, and timely updates. The cited discussion of Philippine conditions supports adapting schedules to local constraints, rather than treating any scheduling technique as sufficient on its own [34].

C. Digital Ecosystems: BIM, 4D Scheduling, and AI

Building Information Modeling (BIM) can support design coordination and information sharing. Linking a model to schedule activities (4D BIM) can help teams visualize sequencing and test alternatives [35]– [37]. Research on machine-learning-assisted scheduling and BIM describes potential automation and decision support [38]. These tools may improve planning when model and schedule data are reliable; the cited literature does not establish that BIM or AI eliminates human error or prevents delays in every project.

Machine-learning and digital-twin applications are emerging research directions in construction planning. The cited work describes methods for generating or synchronizing schedule information from digital models [37], [38]. These approaches require reliable project data, integration with site processes, and human review; the available references do not demonstrate autonomous schedule control across construction projects.

D. Lean Construction and Workability Reliability

Lean Construction approaches focus on improving workflow reliability and reducing avoidable waiting, movement, and rework. The Last Planner System (LPS) uses collaborative planning and measures such as Percent Plan Complete to assess the reliability of promised work [41], [42]. Constraint review can help teams release activities when prerequisites are sufficiently ready. 5S and visual management can support organized work areas [43]. Case-based and project-level studies discuss potential performance gains, but results should be interpreted within their specific activities and settings [30], [40].

V. SYNTHESIS OF REVIEWED EVIDENCE

The evidence synthesized here spans high-rise buildings, other building projects, and adjacent infrastructure sectors. Because these project groups differ in scale, procurement, and technical requirements, this review treats cross-study comparisons as contextual rather than as pooled estimates.

A. Cross-Context Comparison

The reviewed case studies associate schedule overruns with financial, organizational, design, procurement, and external constraints. Available evidence does not support a simple developing-versus-developed country dichotomy: reported factors vary across country, project type, study design, and sample. The review therefore compares specific study contexts and avoids attributing one profile to an entire economic group. In particular, infrastructure studies are not used as direct evidence for vertical construction.

B. Applied Mitigation Techniques and Effects

The mitigation literature includes risk assessment, schedule monitoring, decision support, and contract administration. Several sources concern infrastructure or general construction rather than vertical buildings, so the strategies below are presented as transferable options requiring project-level evaluation [13], [45], [47]. Public-building and general delay-mitigation studies also describe approaches that must be interpreted within their settings [50].

a. Risk Diagnostics. Probability-impact matrices and cause-and-effect diagrams can help teams identify and prioritize supply-chain or cash-flow risks during planning [46]. Their usefulness depends on the quality of project information and follow-up controls.

b. Advanced Scheduling Implementation. Scheduling software such as Primavera P6 can support baseline development, progress tracking, and resource review [48]. It does not replace reliable status data, schedule logic, or management decisions.

c. Experiential Decision Models. Case-Based Reasoning has been proposed as a way to organize and reuse lessons from prior delay cases [49]. Its value depends on the similarity and quality of the historical cases available to the project team.

d. Contract Administration. Clear contract requirements, timely notices, and documented decisions can help teams manage delay claims and disputes [44]. Contract provisions should be interpreted for the specific project and governing legal framework.

C. High-Rise and Commercial Case Studies in the Philippine Context

The Philippine studies reviewed point to different priorities in different settings. The Pampanga vertical-construction study emphasizes market and price-related conditions [12], while the Cebu study highlights management and workforce issues [15]. The Mati comparison differentiates project-group findings [14], and the Apayao study provides evidence from geographically isolated public projects [8]. The latter two settings should not be presented as direct proxies for high-rise development. Manila-focused BIM research discusses information coordination as a potential area for digital support [35], [36]. Taken together, these studies support a localized risk assessment and a careful separation of direct vertical-building evidence from adjacent project evidence.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

This review examined reported delay factors, consequences, and mitigation approaches in vertical construction, with particular attention to evidence from the Philippines. The studies identify recurring concerns involving contractor financing, the timing of owner resources, site coordination, design and approval processes, workforce conditions, procurement, and material availability. Their relative importance varies by project and location; the reviewed evidence does not support a universal country-level ranking or a simple distinction between developing and developed countries. Philippine sources similarly describe distinct patterns in Pampanga, Cebu, Mati, and Apayao, with only some directly focus on vertical construction.

Reported consequences include extended project costs, schedule disruption, additional overheads, and potential congestion or rework during recovery efforts. Estimates from roads and power projects are sector-specific and are not treated as averages for building projects. The findings support project-level tracking of schedule and cost performance, along with clear documentation of events and affected activities.

The findings support matching mitigation to identified risks. CPM or PERT can provide a schedule baseline; risk and cash-flow controls can address uncertainty in resources and procurement; 4D BIM may support coordination where model and schedule data are reliable; and lean planning can help teams resolve constraints and improve workflow

reliability. These approaches are options supported by a mixed body of literature rather than guaranteed solutions. Further review work should report a reproducible search and screening process and, if bibliometric claims are made, use complete bibliographic records.

B. Recommendation

The following recommendations are based on the reviewed evidence and should be evaluated against project data:

a. Project teams may link a coordinated BIM model to the construction schedule to visualize work sequences and identify design or access conflicts. They should verify model quality and ensure that schedule updates reflect the approved scope and actual progress.
b. Project managers may use collaborative look-ahead planning, constraint logs, and Percent Plan Complete to improve the reliability of near-term work. 5S and visual management may support site organization where appropriate.
c. Owners may strengthen financial and procurement controls through proportionate contractor prequalification, realistic work programs, timely payment administration, and monitoring of material availability and cash-flow risks.
d. Owners, contractors, and public agencies should clarify approval responsibilities, contract notice requirements, and dispute-escalation procedures at the start of the project. Digital procurement or permitting tools may help when supported by appropriate processes and implementation capacity.

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