

Governing Time: An Internal Audit Framework to Mitigate Delays in Public Construction Projects

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Abstract

This study examines how internal audit can contribute to schedule assurance in public construction projects. Although construction-delay research has extensively examined the causes of schedule slippage, the role of internal audit in assuring schedule governance remains comparatively underexplored. The empirical evidence covers 60 public building projects managed by a single national institution in Morocco. We measure procurement cycle time, approval-to-start-order lead time, and execution overrun relative to contractual duration, and analyse project records to identify recurrent delay mechanisms. Data are drawn from the institution's procurement register and project files, covering contracts dated 2019 to 2022. Results show that 30.0% of projects were completed on time or early, 11.7% exceeded contractual duration by more than 100%, and 13.3% received the start order within the 30-day benchmark. Recorded explanations include late drawings, pending permits, interdepartmental circulation of files, and slow approval of variation orders. Exploratory chi-square tests detect no statistically significant association between overrun category and contract value, project type, or procurement duration, but small expected cell counts prevent interpreting non-significance as independence. Drawing on agency theory, institutional theory, and the Three Lines Model, we develop a schedule-assurance framework with five audit checkpoints, measurable indicators and propositions for future testing. The contribution combines descriptive empirical evidence and conceptual development rather than causal evaluation. The portfolio contains no measure of audit intervention, recorded explanations may be affected by reporting bias, and findings are specific to a single-institution, single-country setting. Comparative studies and prospective pilots are needed to assess effectiveness and transferability across other public owners and procurement regimes.

Keywords: internal audit; schedule assurance; construction delay; project governance; public procurement; Three Lines Model; Morocco.

JEL Classification: H57; H83; L74; M42; O22

Paper type: Empirical research (exploratory case study with conceptual framework development).

Résumé

Cette étude examine la contribution potentielle de l'audit interne à l'assurance des délais dans les projets publics de construction. Malgré une littérature abondante sur les retards, le rôle de l'audit interne dans la gouvernance temporelle reste comparativement peu étudié. L'analyse porte sur 60 projets de bâtiments publics gérés par une seule institution nationale au Maroc. Elle mesure la durée de passation, le délai entre approbation et ordre de service et le dépassement de la durée contractuelle. Les données proviennent du registre des marchés et des dossiers de projets de l'institution, pour des marchés datés de 2019 à 2022. Les résultats montrent que 30,0 % des projets sont achevés dans les délais ou en avance, que 11,7 % dépassent de plus de 100 % leur durée contractuelle et que 13,3 % reçoivent l'ordre de service dans les 30 jours. Les explications documentées dans les dossiers concernent notamment les plans tardifs, les autorisations, la circulation des dossiers et les avenants. Les tests exploratoires ne détectent aucune association significative entre dépassement et montant du marché, type de projet ou durée de passation ; les faibles effectifs imposent la prudence. En mobilisant les théories de l'agence et institutionnelle ainsi que le modèle des trois lignes, l'étude propose, à partir de données descriptives et sans démonstration causale, un cadre d'assurance des délais en cinq points de contrôle, des indicateurs mesurables et des propositions testables. L'absence de mesure des interventions d'audit, le biais possible des motifs enregistrés et le caractère mono-institutionnel et mono-pays limitent la portée des résultats. Des évaluations prospectives et des répliques comparatives permettront d'apprécier l'efficacité et la transférabilité du cadre à d'autres maîtres d'ouvrage publics.

Mots-clés : audit interne ; assurance des délais ; retards de construction ; gouvernance de projet ; marchés publics ; modèle des trois lignes ; Maroc.

Classification JEL : H57 ; H83 ; L74 ; M42 ; O22

Type du papier : Recherche empirique (étude de cas exploratoire à visée conceptuelle).

1. Introduction

Previous empirical studies provide extensive evidence on the causes of delay in construction projects (Assaf & Al-Hejji, 2006; Sambasivan & Soon, 2007; Sweis et al., 2008; Doloi et al., 2012). Most rank delay causes from surveys of owners, consultants, and contractors and repeatedly identify change orders, slow decisions and approvals, inadequate planning, financing and payment delays, and shortages of labor and materials. A second strand explains chronic overruns through biased estimates at the approval stage (Flyvbjerg et al., 2002; Flyvbjerg, 2014; Love et al., 2012). These recurring families of causes do not imply a universal ranking because their relative importance varies across countries, sectors, project types, procurement arrangements, and institutional settings. This contextual heterogeneity makes it important to examine how the governance of public projects generates elapsed time and which organizational function can independently provide assurance over that governance.

Internal audit has moved from a predominantly compliance-oriented activity toward assurance and advice on governance, risk management, and control (IIA, 2020; Lenz & Hahn, 2015; Roussy & Brivot, 2016). In the public sector, however, engagement with capital projects often remains retrospective and focused on regularity of expenditure (Goodwin, 2004; Arena & Azzone, 2009). Project-governance studies recommend gates, stage reviews, and steering committees (Müller, 2009; Too & Weaver, 2014), but they provide limited guidance on which function should independently verify that these mechanisms operate as intended. The schedule dimension of public construction therefore provides a relevant setting for connecting project-governance and internal-audit research.

We examine schedule-delay patterns in a portfolio of 60 public building projects delivered by a single national institution in Morocco and develop a framework for embedding internal audit in schedule assurance. The case was selected for analytical relevance rather than statistical representativeness. The institution manages a diversified portfolio of public building projects under standardized internal procedures and the national public-procurement framework, providing a suitable setting for examining recurrent schedule-governance issues across multiple projects. The institution has an internal audit unit, which makes it a relevant setting for studying the interface between project governance and internal audit; other institutional details are withheld for confidentiality. We use project records rather than perception surveys and measure procurement cycle time, approval-to-start-order lead time, and schedule overrun relative to contractual duration.

The literature considered in this study links construction delays to project governance and internal-audit effectiveness, but, to our knowledge, provides limited record-based evidence on how independent assurance addresses procurement, mobilization, and execution time jointly. Project-level work exists, notably the design of an audit process for an IT infrastructure project in Indonesia (Pratami et al., 2018), so the gap concerns portfolio-level, record-based evidence on schedule assurance rather than the absence of any research connecting audit and infrastructure. The review is narrative and selective; it was not conducted as a systematic search, and the gap is therefore stated as a limitation of the evidence we identified, not as proof that no other work exists. Our focus is the articulation of auditable schedule-governance mechanisms with portfolio-level observations.

Accordingly, this study addresses the following research question: How can internal audit contribute to improving schedule assurance in public construction projects characterized by recurring administrative and governance-related delays?

The theoretical contribution lies in connecting agency theory, institutional theory, and the Three Lines Model to explain how internal audit can contribute to schedule assurance in public construction projects.

The empirical contribution lies in using record-based evidence from 60 public building projects to document procurement, mobilization, and execution delays rather than relying solely on perception-based surveys. The framework is grounded in these observations but is not causally tested by them. In particular, associations between project attributes and overrun categories do not measure the effect of an audit intervention.

The remainder of this paper is organized as follows. We present the literature review and the theoretical framework in Section 2. We describe the data and methodology in Section 3. We present our empirical results in Section 4. We present the schedule-assurance framework and discuss it in Section 5. We conclude in Section 6.

2. Literature review and theoretical framework

2.1. Construction delays

Previous studies indicate that construction delay is frequently studied through the perceptions of project participants. Assaf and Al-Hejji (2006) reported owner change orders as a major cause in Saudi Arabia; Sambasivan and Soon (2007) emphasized contractor planning, site management, finance, and subcontractors in Malaysia; and studies in Jordan, Nigeria, Ghana, Indonesia, and India likewise identified combinations of owner, contractor, coordination, and financial factors (Odeh & Battaineh, 2002; Aibinu & Jagboro, 2002; Frimpong et al., 2003; Kaming et al., 1997; Sweis et al., 2008; Doloi et al., 2012). Evidence from Morocco broadly confirms the importance of organizational and managerial factors. Challal and Tkouat (2012) identified causes of deadline slippage in Moroccan construction projects, while Bajjou and Chafi (2020) found delayed payments, unrealistic contractual durations, permit delays, ineffective planning and scheduling, and insufficient collective planning among critical delay factors. Although owner-related, administrative, planning, and coordination factors recur across studies, the rankings differ: owner change orders are highlighted in the Saudi evidence, whereas contractor planning, site management, and finance are emphasized in the Malaysian evidence, and relative importance also varies with sector, project type, procurement arrangements, and institutional setting. The literature therefore suggests recurrent families of delay drivers rather than a universal ranking.

Two features of this literature matter for our study. First, many highly ranked causes concern coordination, decision rights, planning, and control rather than engineering alone. Second, much of the literature, including prominent Moroccan evidence, remains perception-based. Record-based studies that decompose actual project duration into contractual time, administrative lead times, stoppages, and execution overrun remain comparatively scarce in the public sector. This distinction motivates the use of project records in the present study.

A distinct strand explains chronic overrun by biased forecasts at approval. Flyvbjerg et al. (2002) showed that cost underestimation in public works is systematic and cannot be explained by error, and Flyvbjerg (2014) extended the argument to schedules and benefits. Love et al. (2012) argued that overruns in social infrastructure also reflect scope changes and errors during delivery. This strand implies that independent challenge of the baseline is a condition for realistic schedules, but it does not say which function inside a public organization should provide it.

2.2. Project governance

Project governance concerns the arrangements through which authority, accountability, oversight, and decisions are organized around projects. This perspective extends beyond the execution of planning tasks to the relationships between the project, its sponsor, and the permanent organization (Müller, 2009; Ahola et al., 2014; Too & Weaver, 2014). A public construction project may have a formally approved schedule while decisions needed to

implement it remain dispersed among technical, financial, and administrative units. Examining these interfaces helps distinguish schedule preparation from the governance of elapsed time.

The temporary organization of a project must coordinate with permanent organizational processes and external participants (Turner & Müller, 2003). Studies of major projects and construction management emphasize the importance of institutional arrangements, front-end decisions, and coordinated delivery (Miller & Lessard, 2000; Winch, 2010; Morris, 2013). For the present framework, these contributions motivate independent scrutiny of readiness, approval workflows, and baseline changes. They do not imply that an auditor should assume the sponsor's decision rights or the project manager's responsibility for delivery.

2.3. Internal audit and project assurance

The Three Lines Model positions internal audit as the third line: management owns and manages risk, specialist functions such as risk, compliance, and the project management office support and challenge, and internal audit provides independent assurance to the governing body (IIA, 2020). COSO supplies control components against which auditors assess controls (COSO, 2013). Arena and Azzone (2009), Sarens and De Beelde (2006), Lenz and Hahn (2015), Roussy and Brivot (2016), and Goodwin (2004) show that internal-audit effectiveness depends on organizational links, expectations, competence, quality, and the public-sector context. Recent developments in continuous auditing and audit analytics extend assurance beyond periodic retrospective reviews. Continuous auditing uses more frequent or automated evaluation of transactions, controls, and risk indicators, while audit analytics can identify patterns, anomalies, and emerging risks across large data sets (Chan et al., 2018; Byrnes et al., 2018). In project environments, these approaches can support more timely assurance over schedule deviations, approval-cycle times, milestone performance, and recurring delay signals, subject to data availability, system integration, auditor competence, and independence. In the public sector, supreme audit institutions also review the economy, efficiency, and effectiveness of public programmes through performance audit (INTOSAI, 2016), which offers a normative basis for examining the timeliness of capital projects, but the internal-audit literature says little about how this logic applies to schedule governance inside the owner organization.

In light of these studies, we contribute by studying the schedule dimension of public construction from an internal-audit perspective. We use project records rather than surveys, quantify gaps between codified timelines and administrative practice, and connect project-governance, construction-delay, and internal-audit literatures that have largely developed separately. The limited project-specific evidence, such as Pratami et al. (2018) on an IT infrastructure project, further supports the need for portfolio-level research on schedule assurance.

2.4. Theoretical framework and propositions

We mobilize three complementary perspectives, each explaining a different part of the mechanism through which internal audit could improve schedule performance.

The theoretical propositions developed below are denoted TP1 to TP3, where TP stands for Theoretical Proposition. Figure 1 links the three foundations, TP1 to TP3, and the checkpoints presented in Table 5.

2.4.1. Agency theory

Agency theory models the relationship between a principal who delegates work and an agent who performs it under information asymmetry and divergent interests (Jensen & Meckling, 1976; Eisenhardt, 1989a). Public construction is a chain of such relationships: the public owner delegates to its technical departments, which delegate to designers and contractors. At each link, the agent knows more about the state of the work, design completeness, permit status,

likely duration, than the principal. Delay is, in this reading, an agency cost. Monitoring reduces agency costs by reducing information asymmetry, and internal audit is the organization's dedicated monitoring mechanism. Applied to schedule, monitoring means verifying before commitment that the conditions for meeting the baseline exist, and verifying during execution that deviations are surfaced rather than absorbed silently.

TP1. Early integration of internal audit in the planning and procurement phases is associated with lower schedule slippage.

2.4.2. Institutional theory

Institutional theory explains why organizations persist with practices that do not serve performance: practices are maintained because they are legitimate rather than efficient (Meyer & Rowan, 1977; DiMaggio & Powell, 1983). Public procurement is such a field. The sequence of visas, approvals, and orders through which a contract passes is prescribed by regulation and sustained by departmental routines; its time cost is invisible because no actor is accountable for elapsed time, only for the correctness of each step. Audit is itself an institution, a ritual of verification that confers legitimacy (Power, 1997), but it can also make the time cost of routines visible by measuring elapsed time against regulatory limits and reporting the gap to the governing body. Its effect therefore depends on the surrounding governance: a finding that a start order is three months late has no effect if no one owns the approval workflow.

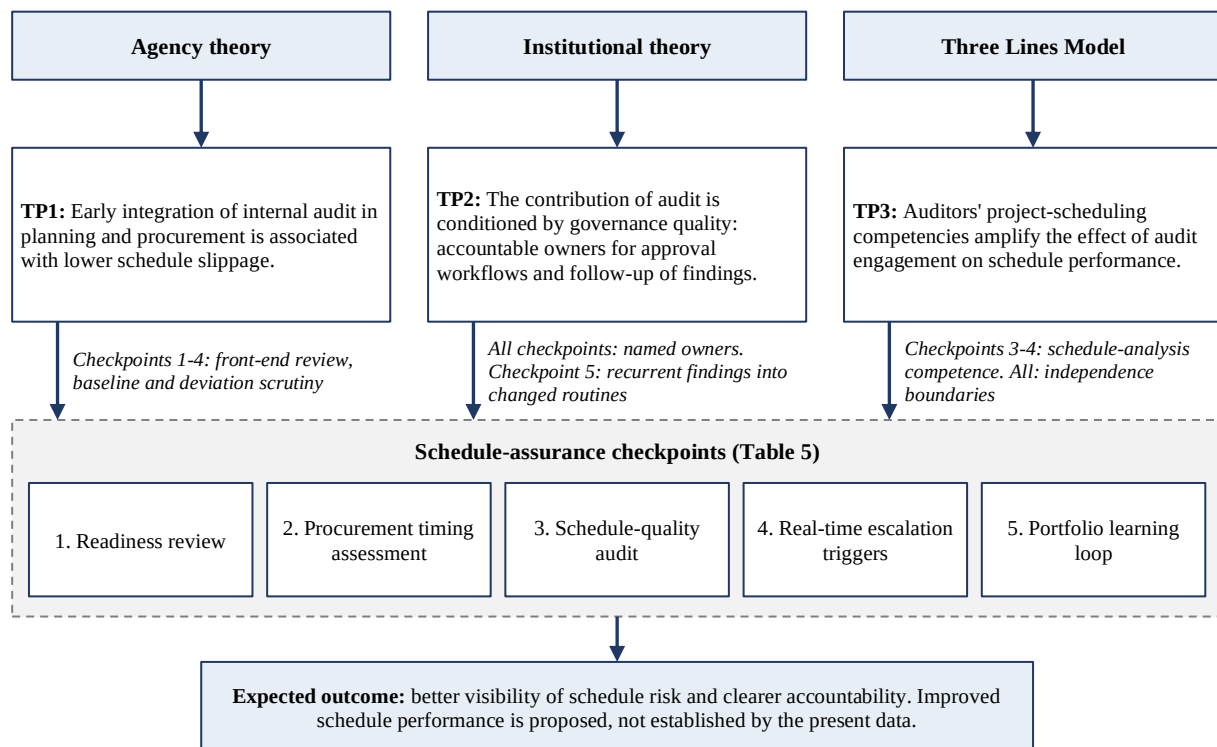
TP2. The contribution of internal audit to schedule performance is conditioned by governance quality, particularly explicit accountability for approval workflows and responses to audit findings.

2.4.3. The Three Lines Model

The Three Lines Model separates management responsibility for achieving objectives and managing risk from internal audit's independent assurance role (IIA, 2020). Applying this distinction to construction schedules requires auditors to understand planning logic without preparing the baseline, approving variations, or authorizing the start of works. Scheduling competence supports the identification of unrealistic assumptions and weak controls; it does not transfer operational ownership to audit. TP3 therefore concerns the capability needed to perform credible schedule assurance, while the governance arrangements in TP2 determine whether findings lead to action.

TP3. The project-scheduling competencies of auditors amplify the effect of audit engagement on schedule performance.

Figure 1: Theoretical foundations, propositions, and checkpoint relationships



Source: Authors. Conceptual synthesis; links are propositions rather than estimated causal effects.

3. Methodology

3.1. Case selection and data

Our data cover a portfolio of 60 public building projects, 36 new constructions and 24 major rehabilitations, managed under a single national public institution in Morocco. All projects were procured, executed, and supervised under standardized institutional procedures and the national public-procurement framework. Contract values range from approximately 1 to 30 million Moroccan dirhams (MDhs): 36 projects below 5 MDhs, 16 between 5 and 10 MDhs, and 8 above 10 MDhs. The institution was selected for analytical relevance because the portfolio provides repeated observations of the same governance and procurement interfaces across heterogeneous public-building projects. The procurement register identifies contracts dated 2019 to 2022. This contract-date range is distinct from the period over which their execution was observed.

3.2. Operational measures

Procurement cycle time is measured in calendar days from the recorded invitation or tender-launch date to the recorded approval/notification date. It is calculated as the difference between these dates for each of the 60 contracts. This operational definition follows the available register; it should not be confused with a distinct award-decision date where approval and notification occur later. The classes are fewer than 30 days, 30-60 days inclusive, 61-90 days inclusive, and more than 90 days.

Approval-to-start-order lead time is the interval between the recorded contract approval/notification date and the start order. The analysis uses the 30-day benchmark of Article 40 of the CCAG-Travaux approved by Decree No. 2-14-394 of 13 May 2016 (Royaume du Maroc, 2016), which requires the start order to be issued within 30 days following the date of notification of contract approval. The distribution is reported in four non-overlapping classes:

at most 30 days, 31-60 days, 61-90 days, and more than 90 days. Benchmark exceedance is a screening indicator; a legal compliance finding also requires checking the applicable contractual provisions, notification dates, and any permitted exceptions.

Execution overrun is the actual execution duration minus the contractual duration, divided by the contractual duration and multiplied by 100. The categories are on time or early (overrun at most zero), above zero to 50% inclusive, above 50% to 100% inclusive, and above 100%. An overrun above 100% means that actual duration exceeds twice the contractual duration. Contract values are grouped below 5 MDhs, from 5 to 10 MDhs inclusive, and above 10 MDhs. These boundaries avoid assigning a project to two classes.

3.3. Documentary analysis and exploratory tests

The design is a single embedded case study (Yin, 2018): the institution is the case and the 60 projects are the embedded units of analysis. The first author coded the records thematically across three lenses: delay drivers, governance practices, and the positioning of the audit function. An initial code list derived from the literature was applied to the records and refined iteratively, following the logic of theory building from case evidence (Eisenhardt, 1989b; Eisenhardt & Graebner, 2007), until categories stabilized across the portfolio. Because the analysis was not based on independent parallel coding by multiple researchers, no formal inter-coder reliability coefficient was calculated. The stated motives of stoppage orders were treated as contemporaneous documented explanations rather than as an exhaustive account of all causal mechanisms.

The three cross-tabulations use the aggregated counts compiled from the institution's project records. Pearson chi-square statistics are recalculated without continuity correction and reported with degrees of freedom and asymptotic p-values. These tests describe exploratory associations, not causal effects. Expected frequencies are below five in 8 of 12 cells for contract value, 3 of 8 cells for project type, and 11 of 16 cells for procurement duration. Minimum expected frequencies are below one in the value and procurement tables. These sparse tables weaken the chi-square approximation, particularly for procurement duration; non-significant p-values cannot establish independence. As a robustness check, Monte Carlo permutation p-values conditional on the observed margins (100,000 permutations) are 0.53 for contract value, 0.49 for project type, and 0.08 for procurement duration, and lead to the same conclusions. Confirmatory testing would still require adequate sample sizes and a design suited to the research question.

3.4. Scope and limitations

The analysis is retrospective and primarily descriptive. Project-level records are confidential, so the manuscript reports aggregated distributions. Inferential analysis is limited to exploratory chi-square tests that can be calculated from aggregated contingency tables; these tests are interpreted cautiously where expected cell frequencies are small. The data contain no measure of the timing or intensity of audit interventions, so the effectiveness of the proposed framework cannot be tested with this portfolio. The portfolio is drawn from a single institution in a single country. A further limitation concerns recording bias in documented delay causes: stoppage orders and delay justifications are produced by project actors, so internally generated causes may be underreported while external causes may be more readily documented. Recorded causes are therefore interpreted as documented explanations rather than as a fully objective and exhaustive causal account. Thematic coding was carried out by a single researcher without an inter-coder reliability check, which exposes the coding to single-coder bias. Institutional characteristics such as the size of the building programme and the organization of the audit unit are not reported for confidentiality reasons, which limits the assessment of representativeness.

The literature review is narrative and was not conducted as a systematic search, so the identified gap reflects the evidence we reviewed rather than an exhaustive mapping of the field.

The procurement distribution was calculated from the 60 contract-level dates recorded in the register. The other distributions are reported as aggregated counts because project-level records are confidential; they allow the reported tests to be recalculated, but readers cannot reconstruct project-level joins from them. The study also lacks a documented measure of audit exposure. Consequently, neither the numerical associations nor the recorded explanations demonstrate that a particular audit checkpoint reduces delay.

Separately from the coding of the 60 project files, the first author reviewed 20 internal audit reports issued between 2017 and 2022 to characterize the institution's audit-reporting context. These reports were used only as contextual evidence and were not included in the thematic coding or in the statistical analyses. The project portfolio contains no measure of the timing or intensity of audit interventions, so this contextual review does not establish the frequency or effectiveness of past audit interventions.

4. Results

4.1. Procurement and mobilization durations

Table 1 presents the distributions of procurement cycle time and approval-to-start-order lead time. Two contracts (3.3%) completed the recorded procurement interval in fewer than 30 days. The modal class is 30-60 days, while 35 contracts (58.3%) exceed 60 days. For approval-to-start-order lead time, eight contracts (13.3%) are within the 30-day benchmark and 52 (86.7%) exceed it; 18 (30.0%) exceed 90 days.

Table 1: Procurement and approval-to-start-order durations (n = 60 per measure)

Measure	Duration	Projects	Share
Procurement	< 30 days	2	3.3%
Procurement	30-60 days	23	38.3%
Procurement	61-90 days	16	26.7%
Procurement	> 90 days	19	31.7%
Procurement total		60	100.0%
Approval to start order	0-30 days	8	13.3%
Approval to start order	31-60 days	28	46.7%
Approval to start order	61-90 days	6	10.0%
Approval to start order	> 90 days	18	30.0%
Lead-time total		60	100.0%

Source: Authors, from the institution's procurement register and project records (aggregated counts). Percentages may not sum exactly due to rounding.

4.2. Execution overruns

Eighteen projects (30.0%) were completed on time or early. Twenty-five (41.7%) exceeded contractual duration by more than zero and at most 50%, ten (16.7%) by more than 50% and at most 100%, and seven (11.7%) by more than 100%. Thus, 42 projects (70.0%) were late, and seven took more than twice their contractual duration. The same category totals are reconciled across Tables 2 to 4.

4.3. Contract value and schedule performance

Table 2 presents schedule overrun by contract-value band. The mid-value band (5-10 MDhs) shows the highest share of extreme overruns and the lowest share of on-time completions, while the highest band (> 10 MDhs) fares worse than the lowest band on on-time completion but better than the mid band on extreme overruns. A chi-square test of independence does not indicate a statistically significant association between contract-value band and schedule-

overrun category, $\chi^2(6) = 5.30$, $p = 0.506$. Because several expected frequencies are below five, particularly in the higher-value bands, this result is exploratory. The evidence therefore does not support a clear monotonic relationship between contract value and schedule performance.

Table 2: Schedule overrun by contract value (n = 60)

Group	n	On time / early	> 0 to 50%	> 50 to 100%	> 100%
< 5 MDhs	36	14 (38.9%)	13 (36.1%)	6 (16.7%)	3 (8.3%)
5-10 MDhs	16	2 (12.5%)	9 (56.3%)	2 (12.5%)	3 (18.8%)
> 10 MDhs	8	2 (25.0%)	3 (37.5%)	2 (25.0%)	1 (12.5%)
Total	60	18 (30.0%)	25 (41.7%)	10 (16.7%)	7 (11.7%)

Source: Authors, from the institution's project records (aggregated counts). Parentheses show row percentages.

4.4. Project type and schedule performance

Table 3 compares schedule performance between new construction and major rehabilitation projects. New construction projects account for six of the seven overruns above 100%, but the overall distribution does not differ significantly by project type. A chi-square test of independence is not statistically significant, $\chi^2(3) = 2.60$, $p = 0.457$. Given small expected frequencies in some cells, the result is interpreted as exploratory.

Table 3: Schedule overrun by project type (n = 60)

Group	n	On time / early	> 0 to 50%	> 50 to 100%	> 100%
New construction	36	11 (30.6%)	13 (36.1%)	6 (16.7%)	6 (16.7%)
Major rehabilitation	24	7 (29.2%)	12 (50.0%)	4 (16.7%)	1 (4.2%)
Total	60	18 (30.0%)	25 (41.7%)	10 (16.7%)	7 (11.7%)

Source: Authors, from the institution's project records (aggregated counts). Parentheses show row percentages.

4.5. Procurement duration and execution overrun

Table 4 cross-tabulates procurement cycle time and execution overrun to examine whether upstream procurement frictions propagate into execution delay. The chi-square test does not indicate a statistically significant association, $\chi^2(9) = 15.25$, $p = 0.084$. The descriptive pattern is not monotonic: longer procurement cycles are not systematically associated with greater execution overruns. Because several expected frequencies are below five, the test is treated as exploratory. This table is particularly sparse and its asymptotic p-value should not be treated as a confirmatory result. Descriptively, the group with procurement above 90 days has the highest share of projects completed on time or early (10 of 19, 52.6%), against 3 of 23 (13.0%) and 3 of 16 (18.8%) in the 30-60 and 61-90 day groups, while the group below 30 days contains only two contracts.

Table 4: Procurement duration and execution overrun (n = 60)

Group	n	On time / early	> 0 to 50%	> 50 to 100%	> 100%
< 30 days	2	2 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
30-60 days	23	3 (13.0%)	10 (43.5%)	6 (26.1%)	4 (17.4%)
61-90 days	16	3 (18.8%)	8 (50.0%)	3 (18.8%)	2 (12.5%)
> 90 days	19	10 (52.6%)	7 (36.8%)	1 (5.3%)	1 (5.3%)
Total	60	18 (30.0%)	25 (41.7%)	10 (16.7%)	7 (11.7%)

Source: Authors, from the institution's project records (aggregated counts). Parentheses show row percentages.

4.6. Documented delay mechanisms

The documentary account identifies several recurring explanations: late or unavailable execution drawings, pending authorizations, circulation of files between departments, weather-related stoppages, additional works, and approval of variations. These explanations relate to different project phases and may occur together. Their presence in the records does not establish their relative causal contribution; no unverified numerical ranking is assigned to them.

The front-end observations concern readiness and handovers, including designs not finalized before mobilization and files circulated among technical, legal, and financial departments. During execution, recorded issues concern variations, interruptions, and incomplete technical information. These qualitative observations are distinct from the aggregate overrun categories and are subject to the recording limitations described in Section 3.4. Separately, the contextual review of 20 internal audit reports issued between 2017 and 2022 showed that reporting focused mainly on budgetary and procedural regularity and did not systematically analyse schedule performance or recurring delay causes. Because these reports were outside the coded project-file dataset, this observation is treated as institutional context rather than as a project-level explanatory variable.

5. Discussion and schedule assurance framework

5.1. Interpretation of the findings

Our descriptive results are consistent with prior studies identifying owner-related, administrative, planning, and coordination factors among important sources of construction delay (Assaf & Al-Hejji, 2006; Sambasivan & Soon, 2007; Sweis et al., 2008; Challal & Tkouat, 2012; Bajjou & Chafi, 2020). The present study differs methodologically because causes are read from project records rather than ranked retrospectively by respondents. It also locates delay at identifiable regulatory and administrative interfaces. Only 13.3% of the portfolio is within the 30-day approval-to-start-order benchmark, making this interface directly auditable. At the same time, the exploratory tests do not show significant associations between schedule-overrun category and contract value, project type, or procurement-cycle band. These results caution against assuming that larger projects, new construction, or longer procurement necessarily produce greater execution overrun. The higher share of on-time projects in the group with procurement above 90 days (Table 4) reinforces this caution, although sparse cells prevent interpreting it. For the sequencing of the framework, this gives some support to prioritizing checkpoint 1 over checkpoint 2 as a lever on execution overrun, because 86.7% of contracts exceed the 30-day approval-to-start-order benchmark. Checkpoint 2 remains justified by its own indicator, since 35 of 60 contracts exceed 60 days of procurement, but the portfolio provides no evidence that shortening procurement would reduce execution overrun. This ordering is a proposal for pilot sequencing, not an empirical finding.

The absence of a statistically significant result in these small contingency tables does not demonstrate that value, project type, or procurement duration is irrelevant. Nor does it establish governance as the alternative causal explanation. The governance interpretation rests on the documented mechanisms and theoretical argument; the numerical analysis describes how the observed overrun categories are distributed. The non-monotonic procurement pattern also prevents inferring that a longer procurement interval necessarily produces greater execution overrun.

Through the agency perspective, independent scrutiny of readiness and baseline assumptions could reduce information asymmetry before commitments are made (TP1). Institutional theory directs attention to the difference between formally prescribed workflows and actual elapsed time, and to accountability for acting on findings (TP2). The Three Lines Model explains why

this scrutiny must preserve management ownership and why auditors need sufficient scheduling competence to challenge the evidence (TP3). These are explanations supporting the proposed framework, not effects estimated from the portfolio.

5.2. Design principles

The framework rests on four principles. First, we target the interfaces where the portfolio generates elapsed time rather than the whole lifecycle. Second, audit assures but does not decide: each checkpoint produces an audit deliverable addressed to the governing body, and the decisions it informs remain with the first and second lines. Third, every checkpoint is paired with indicators expressed as durations or rates against a regulatory, contractual, or internal target, so that the cost of routines becomes visible (Section 2.4.2). Fourth, findings feed a portfolio-level record so that recurrent causes translate into standards rather than into repeated findings.

5.3. Checkpoints and indicators

Table 5 presents the five checkpoints, the failure mode each addresses, what audit verifies, and the indicators through which its effect can be monitored. The schedule-quality criteria of checkpoint 3, including logic density, lags and constraints, float reasonableness, and critical-path continuity, follow recognized schedule-assessment guidance (GAO, 2015). The escalation values in checkpoint 4 are initial control thresholds for pilot implementation rather than universal constants. They should be calibrated to the organization's project environment and interpreted alongside recognized earned value and schedule-monitoring practices (Project Management Institute, 2019; SAE International, 2026).

The numerical triggers below are author-proposed pilot values. They are not prescribed universal thresholds in the cited standards. For the 10% trigger, the proposed measure is an adverse forecast delay relative to the approved baseline duration, not an undefined earned-value schedule variance. The 14-day approval trigger uses calendar days. Before deployment, management should define event dates, escalation owners, and evidence requirements, and calibrate thresholds using historical cases and pilot observations. Audit reviews this control design without approving operational decisions.

Table 5: Schedule assurance checkpoints and indicators

Checkpoint	Timing	Failure Mode Addressed	What Audit Verifies	Indicators
1. Readiness review	Before the start order	Late start orders; incomplete designs (4.1, 4.6)	Review design completeness, permits, utility interfaces, drawing and quantity consistency, and constructability. Deliverable: independent readiness assessment with exceptions and named management action owners; management authorizes mobilization.	Design completeness; approval-to-start-order days against the applicable benchmark; unresolved readiness exceptions.
2. Procurement timing assessment	Tender launch to approval	Long procurement cycles (4.1)	Completeness of selection criteria; documentation of clarifications; tracking of bid-validity periods; handling of price-readjustment requests; service-level targets for tender milestones.	Tender-launch-to-approval days; bid-validity extensions; share completed within internal service-level targets.
3. Schedule-quality audit	At baseline and re-baselines	Unrealistic baselines; dispersion of overruns (4.2)	Review baseline logic, lags and constraints, float, critical-path continuity, risk-adjusted dates, and formal change control (GAO, 2015).	Schedule-quality score; share of activities on a valid critical path; share of changes through formal baseline control

4. Real-time escalation triggers	During execution	Extreme overruns; unmitigated stoppages (4.2, 4.6)	Review approval queues, requests for information and milestone slippage. Initial pilot triggers: forecast delay / baseline duration at least 10%; variation approval over 14 calendar days; two consecutive missed milestones. Calibrate locally; these values are not mandated by the cited standards.	Variation approval time; request aging; milestone completion rate; forecast delay / baseline duration.
5. Portfolio learning loop	After completion, annually	Recurrence of causes across projects (4.6)	Delay-cause taxonomy; cross-project lessons-learned register; translation of recurrent causes into standards, templates, and training.	Closure rate of recommendations; year-on-year recurrence of top three causes; time to embed a new control

Source: Authors; schedule guidance from GAO (2015), Project Management Institute (2019), and SAE International (2026).

5.4. Organizational enablers

Four conditions determine whether the checkpoints operate as assurance rather than as formality: an audit charter that explicitly extends the scope of the function to schedule assurance; scheduling competencies acquired through training or co-sourcing with planning engineers (TP3); timely access to native schedules, risk registers, approval logs, and decision minutes; and a consultative posture, since management's responsiveness to audit depends on the relationship as much as on the findings (Sarens & De Beelde, 2006; Arena & Azzzone, 2009). The framework is consistent with the Three Lines Model (IIA, 2020), with ISO 21505 (2017) for governance, with ISO 21502 (2020) for project-management processes, and with COSO (2013) for control components. For supreme audit institutions, the indicators map directly onto the criteria of performance auditing under ISSAI 3000 (INTOSAI, 2016).

5.5. Testable propositions

The following propositions translate TP1-TP3 into observable comparisons. A future evaluation should define comparable projects, observation windows, denominators, and a minimally meaningful improvement before analysing outcomes. Confidence intervals and the chosen design should distinguish lack of evidence from a precisely estimated absence of benefit. No effect size is estimated or asserted from the present portfolio.

P1. Projects undergoing a readiness review before the start order are expected to show shorter approval-to-start-order lead times and higher design completeness at the start order than comparable projects without such a review. P1 would not be supported if no improvement is observed on either indicator.

P2. Projects subject to procurement-timing assessments with service-level targets are expected to show a lower proportion of awards in the 61-90-day and over-90-day bands than comparable projects without such assessments. P2 would not be supported if these proportions do not decline.

P3. Projects subject to schedule-quality audits at baseline are expected to show a lower proportion of schedule overruns above 50% than comparable projects without such audits. P3 would not be supported if no reduction is observed.

P4. Projects operating with predefined escalation triggers are expected to show a lower proportion of schedule overruns above 100% than comparable projects without such triggers. P4 would not be supported if the proportion does not decline.

P5. A portfolio learning loop is expected to reduce the year-on-year recurrence of the main delay causes, conditional on the owner assigning accountability for the corresponding

workflows. P5 would not be supported if the recurrence rate remains unchanged or increases over the observation period.

5.6. Boundary conditions

We identify four conditions under which the framework may not work. First, independence capture: the more audit engages with projects, the greater the risk that it becomes co-responsible for decisions; the framework confines audit to review and report, but this safeguard depends on governance oversight. Second, bureaucratization: checkpoints can themselves become routines performed for legitimacy and should be reviewed periodically. Third, governance without ownership: where no actor is accountable for elapsed time, audit findings may document delay without reducing it (TP2). The approval-to-start-order phase illustrates this condition: several files circulated among technical, legal, and financial departments after approval while no single actor owned the elapsed time. In such a setting, audit can identify a bottleneck, but its effect remains limited unless responsibility for the workflow is explicitly assigned. Fourth, capacity: an audit function without scheduling competence is unlikely to provide credible schedule assurance (TP3).

5.7. Pilot implementation and future evaluation

Implementation can begin with a limited pilot covering readiness, approval timing, and schedule-quality review. Management should designate accountable workflow owners and preserve the source records needed to measure each indicator. The audit charter should specify access rights, assurance scope, reporting arrangements, and the decisions that remain outside audit responsibility. A baseline observation period and a prospectively defined comparator would support a more credible evaluation than a simple before-and-after comparison.

During the pilot, audit and management should review indicator definitions, missing records, alert frequency, and the workload generated by the proposed checkpoints. Excessive alerts or duplicated approvals may add delay rather than reduce it. Thresholds should therefore be calibrated transparently, with changes documented before assessing outcomes. Scaling should depend on observed usefulness, implementation costs, and maintenance of independence. Digital tools may support the monitoring of approval queues and schedule changes, but the validity of their signals still depends on consistent dates, reliable records, and accountable action (Chan et al., 2018; Byrnes et al., 2018).

6. Conclusion

This study connects record-based observations from a Moroccan public-building portfolio with a schedule-assurance framework for internal audit. Its contribution is to translate governance-related delay mechanisms into checkpoints, indicators, and testable propositions while preserving the distinction between independent assurance and management responsibility. Agency theory explains the monitoring rationale, institutional theory clarifies why accountability conditions its usefulness, and the Three Lines Model defines role boundaries and capability requirements.

The proposed framework gives public owners and audit functions a basis for examining readiness, procurement timing, baseline quality, escalation, and organizational learning. The portfolio does not establish the effectiveness of these interventions. In particular, exploratory tests with sparse cells cannot justify causal conclusions or demonstrate the absence of relationships between project attributes and schedule performance.

The findings have implications for public owners, regulators, internal audit functions, and supreme audit institutions. Public owners can make elapsed time visible at key interfaces, assign accountable owners to approval workflows, and use independent assurance without transferring management responsibility to audit. Regulators and oversight bodies can complement

compliance criteria with measurable indicators of timeliness, while internal audit functions can progressively develop scheduling and data-analytics capabilities for more timely assurance. The study remains subject to important limitations. The portfolio contains no measure of audit intervention, is reported mainly at the aggregate level, comes from a single institution, and may contain recording bias in the documented causes of delay. The framework is therefore grounded in the evidence but not causally tested by it. Future studies can test P1-P5 prospectively using pilot-control or matched designs, assess the cost-benefit balance of schedule-assurance activities, and examine digital audit analytics for automated schedule-quality checks and approval alerts. Comparative replication across other Moroccan public institutions and countries with similarly codified public-procurement regimes would help assess external validity and distinguish context-specific mechanisms from transferable features of the framework.

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